REQ. NO. 23241-3-1666

CONTRACT REPORT NO. OSQ83-00229

Report on
Assessment of the Mechanism of Bacterially Assisted Oxidation of Pyritic Uranium Tailings

DSS File No. 14SQ.23241-3-1666

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July 1984

150pp

MICROMEDIA

SEP 24 1984

SUMMARY

The oxidation of pyritic minerals has conclusively been shown to be catalyzed by the presence of iron- and sulphur-oxidizing bacteria. Of the various species that have been isolated from pyritic soils, Thiobacillus ferrooxidans plays the most significant role in the formation and propogation of acidic conditions. Optimum growth conditions for the T. ferrooxidans occurs at a temperature of 35°C and pH of 2 to 3.

Bacterially assisted oxidation of pyrite involves both direct and indirect contact mechanisms. The direct contact mechanism entails enzymatic oxidation of the insoluble sulphide moiety. In contrast, the indirect mechanism involves bacterial oxidation of the dissolved ferrous component to the ferric state. The ferric iron, in turn, acts as the prime oxidant of pyrite and is reduced to ferrous iron. The re-oxidation of the dissolved ferrous component which is catalyzed by bacterial activity, completes the cyclic process.

A number of factors have been shown to affect the rate of bacterial oxidation of pyritic material including:

i) the geochemistry and reactivity of the pyritic material;

ii) the amount of pyrite present in the waste material and the exposed surface area of the pyritic component;

iii) the availability of oxygen which is the principal electron acceptor;

iv) the availability of carbon dioxide which is the sole source of carbon for the strictly chemolithotrophic bacteria of interest;

v) the pH of the leach solution (e.g. tailings porewater);

vi) the temperature of the leach solution (e.g. tailings porewater);

vii) the presence (or absence) of organic inhibitors.

Of the above factors, oxygen has been frequently identified as the rate limiting reactant in tailings. Close-out concepts for tailings areas aimed at reducing acid production have generally been developed, therefore, on the basis of minimizing oxygen accessibility to the pyritic material. Experience with such management methods as mine flooding and tailings disposal under a water cover have shown reduced acid production and reduced contaminant mobility.

To provide the National Uranium Tailings Program with a scientifically credible information base upon which tailings management strategies can be evaluated, the following research activities should be considered:

- Field monitoring programs at pyritic uranium tailings areas should include depth profiles of the oxygen, temperature, carbon dioxide and moisture levels in the pyrite oxidizing zone.
- Laboratory scale studies should be undertaken to determine the effects of low oxygen levels, alternate electron acceptors, and carbon dioxide on microbial oxidation kinetics.

- Laboratory scale investigations are required to better define oxygen diffusivity (the principal rate-controlling mechanism affecting pyrite oxidation) through saturated and partially saturated tailings.

- In conjunction with the detailed field monitoring programs at specific tailings sites, concurrent laboratory scale programs should be conducted with the specific objective of developing an improved technique for translating laboratory data to field situations.

- A comprehensive kinetic model should be developed which takes into account those factors having an important bearing on microbial oxidation of pyritic uranium tailings.

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1.0 INTRODUCTION

1.1 Problem Definition

The exposure of reduced sulphur compounds, particularly the iron disulphides, to oxygen and moisture results in the formation of acid. Perhaps the most well-known examples of the oxidation of sulphidic materials are the numerous citings in the literature of acid mine drainage from coal mining operations. Due to the ubiquitous occurrence of the iron sulphide minerals, however, the problems of acid mine drainage are not exclusive to the coal industry. Many base metal, uranium and gold mining operations are also faced with the prospect of treating acid drainage from mine workings, waste rock piles and tailings management facilities.

The predominant iron disulfides (FeS_2) are pyrite and marcasite. Crystalline pyrite is a brittle, pale brass-yellow coloured mineral. Marcasite is a hard, pale bronze-yellow coloured mineral featuring a tinge of green and a metallic luster. Even though pyrite and marcasite have the same sulphur to iron atomic ratios, their crystallographic properties are different. Marcasite has an orthorhombic structure and decomposes more rapidly. Pyrite has a cubic structure. It is generally found in greatest abundance in North American coals and ores and therefore, is usually implicated as being the major source of acid mine drainage.

The oxidation of pyritic material has been shown conclusively to be catalyzed by the presence of iron- and sulphur- oxidizing bacteria. Since the discovery of autotrophic bacteria in acid mine drainage by several investigators working independently in the late 1940's and early 1950's, an extensive amount of laboratory and field work has been performed on evaluating the mechanisms and kinetics of the biologically mediated oxidation-reduction reactions. Autotrophic bacteria use inorganic compounds, primarily dissolved carbon dioxide and bicarbonate, as their carbon source and either light or inorganics as their energy source. There has also been increasing emphasis on means of controlling or eliminating pyrite oxidation. Concurrently, there has been considerable research into the application of biotechnology for the leaching of low-grade ores with several commercial and experimental projects in operation. Many of these are on low-grade copper ores although the applicability to other ores, including low-grade uranium ore, is being pursued. There has also been a growing interest in recent years in the application of biotechnology for coal desulphurization.

With reference to the mandate of the National Uranium Tailings Program (NUTP), the role of bacteria in mediating the oxidation of sulphidic uranium tailings is of specific interest with respect to the effect acidification has on the dissolution of uranium and some other radionuclides. Furthermore, the release of acid and other potentially toxic contaminants is of concern in evaluating and selecting tailings disposal strategies which will permit tailings disposal in an environmentally and socially acceptable manner.

1.2 Study Objectives

The principal objective of the current project as set out in the statement of work was:

> "to develop a summary of the existing data on the influence of bacterial oxidation on sulphidic uranium tailings and evaluate that data. This should be a critical in-depth evaluation which highlights the deficiencies and recommends additional work to eliminate these deficiencies."

To satisfy this objective, it was specified that the contractor will:

"1) Complete a literature search to establish an information base appropriate to the object of this contract. The search will cover such topics as:
   a) basic microbiological studies on micro-organisms isolated from pyritic material;
   b) bacterial leaching of uranium;
   c) modelling of pyritic tailings oxidation;
   d) non-biological redox reaction in pyritic tailings;
   e) effect of acid generation on radionuclide release;
   f) the effects of management technologies on pyrite oxidation;
   g) pyritic tailings disposal strategies.

2) Critically review and assess the database. The data accumulated will be reviewed to assess its overall applicability to the National Uranium Tailings Program. Some thought should be given to the assessment of the data quality. Where possible, the assessment will include statistical analysis of the data.

3) Evaluate radionuclide release mechanisms. The contractor will concentrate on determining the effect of bacterially assisted acid generation on the mobilization of radionuclides. The removal of radionuclides, as a function of the bacteria-assisted pH changes, by various chemical processes will also be reviewed.

4) Identification of deficiencies in the data. The contractor will identify data gaps and deficiencies that will have a major impact on the evaluation of bacterially assisted

pyritic tailings oxidation with subsequent acid generation and radionuclide release. The contractor will also indicate where the predictive models may be sensitive to such data. Once the deficiencies and sensitivities have been defined, the contractor will recommend future studies to complement the existing data and thus meet the objectives of the National Uranium Tailings Program (Item 5).

5) The main objectives of the National Uranium Tailings Program should be borne in mind when designing and carrying out this program. The main objective is to provide a scientifically credible information base on which decisions can be made, with a known degree of confidence in establishing reasonable criteria for the protection of the environment, and which can also be used to propose practical guidelines for Uranium Tailings Management.

6) Present a seminar on the results of this work and the background for it at the NUTP offices in Ottawa on completion of the work."

The requirement of item 1) was fulfilled with a computer-based literature search of a total of eight databases on two separate information services. The abstracts from these databases were published as a separate volume of supplementary appendices to this report. In addition to the computer search, many of the reference documents scrutinized during the evaluation of published literature were used as reference sources for other documents. Numerous articles and documents identified from the literature searches were subsequently acquired. The reviewed literature is cited in the reference listing which forms part of this volume. The specific requirements of items 2), 3) and 4) are addressed in the body of this report.

2.0 BACTERIAL INVOLVEMENT IN PYRITE OXIDATION

2.1 Bacterial Identification, Taxonomy and Physiology

2.1.1 Historical Background

Although bacteria had been implicated to mediate the biogeochemical transformation of pyritic minerals as early as 1919 (Harder 1919), conclusive evidence concerning the ubiquitous presence of iron-oxidizing bacteria in acidic mine water was not obtained until some thirty years later (Colmer and Hinkle 1947, Colmer et al 1950). This discovery led to increased research on the isolation, identification, metabolism, and taxonomy of iron and sulphur oxidizing bacteria. Shortly after, Thiobacillus ferrooxidans, the most prominent iron and sulphur oxidizer in acidic environments, was identified and characterized by Temple and Colmer (1951).

While acidic mine drainage from coal mines in West Virginia provided the initial impetus for the research effort (see review by Gleason et al 1978), the pollutional aspects were soon supplanted by the exploitation of these bacteria for the hydrometallurgical recovery of metals from ores (i.e. bacterial leaching). It is, therefore, not surprising, that the more extensive reviews of the scientific literature, including publications by Duncan and Trussell (1964), Brierley (1978), Murr and Brierley (1978), Lundgren and Silver (1980), Torma and Bosecker (1982), and Torma (1983), addressed bacterial action on sulphidic ores mainly from a hydrometallurgical processing perspective.

Ore deposits in the Elliot Lake area gave the first evidence of bacterial association with uranium ore (Harrison et al 1966a and 1966b). Acting upon observations that mine waters had become acidic and contained appreciable concentrations of dissolved uranium (UO_2^{2+}) and ferric iron (Fe^{3+}), bacteria resembling *T. ferrooxidans* were isolated from mine water and stope ore samples. In laboratory experiments, the bacteria were demonstrated to grow in a solution containing sulphuric acid, iron and uranium. Iron was oxidized from a ferrous to a ferric state. Ferric ion, in turn, leached uranium as uranyl ion (UO_2^{2+}) from the unoxidized ore.

In subsequent years, northern Ontario uranium ore deposits were proven to be a rich source of iron and sulphur oxidizing bacteria. Altogether five distinct strains of *T. ferrooxidans* (DiSpirito et al 1982) and two strains of *T. acidophilus* (Guay and Silver 1975, DiSpirito et al 1982) were isolated from various locations. These isolates differed with respect to flagellation (polar, peritrichous, or absent), pili formation (present or absent) and physiological characteristics. The flagellum consists of long contractile protein strands that bacteria use for locomotion. Polar flagellation refers to flagella at one or both ends of rod shaped bacteria, while peritrichous flagellation means more or less uniform distribution on the entire bacterial surface. Pili refers to hair-like proteinous extrusions that bacteria use for attachment to solids. Natural populations comprised a mixture of metabolically similar, but morphologically distinct organisms. The potential use of bacterial leaching for uranium has been reviewed extensively. According to Brierley (1978), bacterial leaching at Agnew Lake Mines in northern Ontario was the first commercial application at a uranium mine in North America, although underground leaching *per se* had been used previously in Elliot Lake.

2.1.2 Taxonomical and Physiological Properties

The physiological properties of iron and sulphur oxidizing bacteria that have been either isolated from acidic, pyritic soils or have been implicated as being important during the development of acidic conditions are summarized in Table 2.1. Optimum growth has been observed at either mesophilic (20 to 40°C) or thermophilic (above 40°C) temperatures. Although bacterial activity is detectable at temperatures as low as 6°C, the known mesophiles grow slowly on non-soluble substrates such as pyrite below 10°C.

The conspicuous absence of psychrophilic (i.e. optimum growth below 20°C) sulphur oxidizing bacterium in Table 2.1 is remarkable. To date, no true psychrophile has been isolated. It is a matter of conjecture whether this is due to some basic physiological reason, or whether it simply reflects the thrust of research to isolate bacteria for optimal leaching of sulphide ores.

Since these bacteria can generate metabolically useful energy by oxidizing inorganic compounds (e.g. reduced sulphur species, iron, etc.), they are collectively referred to as chemolithotrophs. Dissolved carbon dioxide (CO_2) is the primary source of carbon in several species. Obligate chemolithotrophs use inorganics exclusively as their energy source and carbon dioxide as their carbon source in their normal habitat. Of the bacteria listed in Table 2.1, T. denitrificans, T. ferrooxidans, T. neapolitanus, T. thiooxidans, and T. thioparus, are generally regarded as obligate chemolithotrophs. The inability to obtain energy from organic sources is thought to be due either to the absence of -ketoglutarate oxidoreductase or the low activity of succinate and malate dehydrogenase of the Krebs cycle enzymes (Figure 2.1), as well as an inefficient intracellular transport mechanism for organic substrates (Matin 1978).

The incorporation of simple organic carbon sources (acetate, for

TABLE 2.1

Physiological Properties of Bacteria Having Potential Implication in Pyrite Oxidation

Organism	Temp. Range of Growth (Optimum) °C	pH Range of Growth (Optimum)	Primary Substrates	Primary Carbon Sources	Nitrogen Sources	Terminal Electron Acceptor
Thiobacillus ferrooxidans	10 - 65 (35 - 45)	1.5 - 5.0 (2 - 3)	ferrous ion, sulphur, metal sulphides	dissolved carbon dioxide, bicarbonate	ammonia, nitrogen gas	dissolved oxygen (ferric ion in anoxic environment)
Thiobacillus thiooxidans	15 - 40 (28 - 30)	0.5 - 6.0 (2.0 - 3.5)	sulphur, thiosulphate, sulphide	dissolved carbon dioxide, bicarbonate	ammonia	dissolved oxygen
Thiobacillus acidophilus and Thiobacillus organoparus	20 - 37 (25 - 30)	1.5 - 6.0 (3.0)	sulphur or organics	dissolved carbon dioxide, bicarbonate, organics	ammonia	dissolved oxygen
Thiobacillus thioparus	23 - 37	4.5 - 7.8 (7.0)	sulphur, thiosulphate, thiocyanate	dissolved carbon dioxide, bicarbonate	ammonia, nitrate	dissolved oxygen
Thiobacillus neapolitanus	23 - 37	4.5 - 7.8 (7.0)	sulphur, thiosulphate	dissolved carbon dioxide, bicarbonate	ammonia, nitrate	dissolved oxygen
Thiobacillus novellus	20 - 40	5 - 9.5 (7.0)	thiosulphate, organics	dissolved carbon dioxide, organics	ammonia, organics	dissolved oxygen
Thiobacillus A2	20 - 40	5 - 9.5	thiosulphate, organics	dissolved carbon dioxide, organics	ammonia, organics	dissolved oxygen (nitrate in anoxic environment)
Thiobacillus intermedius	20 - 40	2.0 - 7.0	sulphur, organics	dissolved carbon dioxide, organics	ammonia	dissolved oxygen
Thiobacillus denitrificans	20 - 40	6 - 8	sulphur, thiosulphate, dithionate, tetrathionate, sulphide	dissolved carbon dioxide, bicarbonate	nitrate	dissolved oxygen, (nitrate in anoxic environment)

Table 2.1 continued

Organism	Temp. Range of Growth (Optimum) °C	pH Range of Growth (Optimum)	Primary Substrates	Primary Carbon Sources	Nitrogen Sources	Terminal Electron Acceptor
Thiobacillus perometabolis	20 - 30 (30)	2.8 - 9.0	sulphur, thiosulphate and organics	organics	organics, ammonia	dissolved oxygen
Metallogenum	20 - 40	3.5 - 6.8	Ferrous ion, manganese	dissolved carbon dioxide	ammonia	dissolved oxygen
Sulfolobus thermosulfidooxidans Sulfolobus acidocaldarus	55 - 90+ (65 - 80)	1 - 5.9 (2 - 3.0)	sulfur metal sulphides, ferrous ion, molybdenum	dissolved carbon dioxide (organics)	ammonia	dissolved oxygen (ferric ion in anoxic environment)
Sulfolobus like organisms	45 - 70 (55 - 65)	1 - 7.0	ferrous ion, sulphur	dissolved carbon dioxide (organics)	ammonia	dissolved oxygen (molybdenate in microaerophilic environment)
Thermoplasma acidophila	37 - 65	0.5 - 4.3	sulphur plus organics	organics (dissolved carbon dioxide)	ammonia	dissolved oxygen
Thiobacillus thermosulfidooxidans	37 - 55	1.5 - 5.0	ferrous ion, pyrite, sulphur plus organics	dissolved carbon dioxide	ammonia	dissolved oxygen

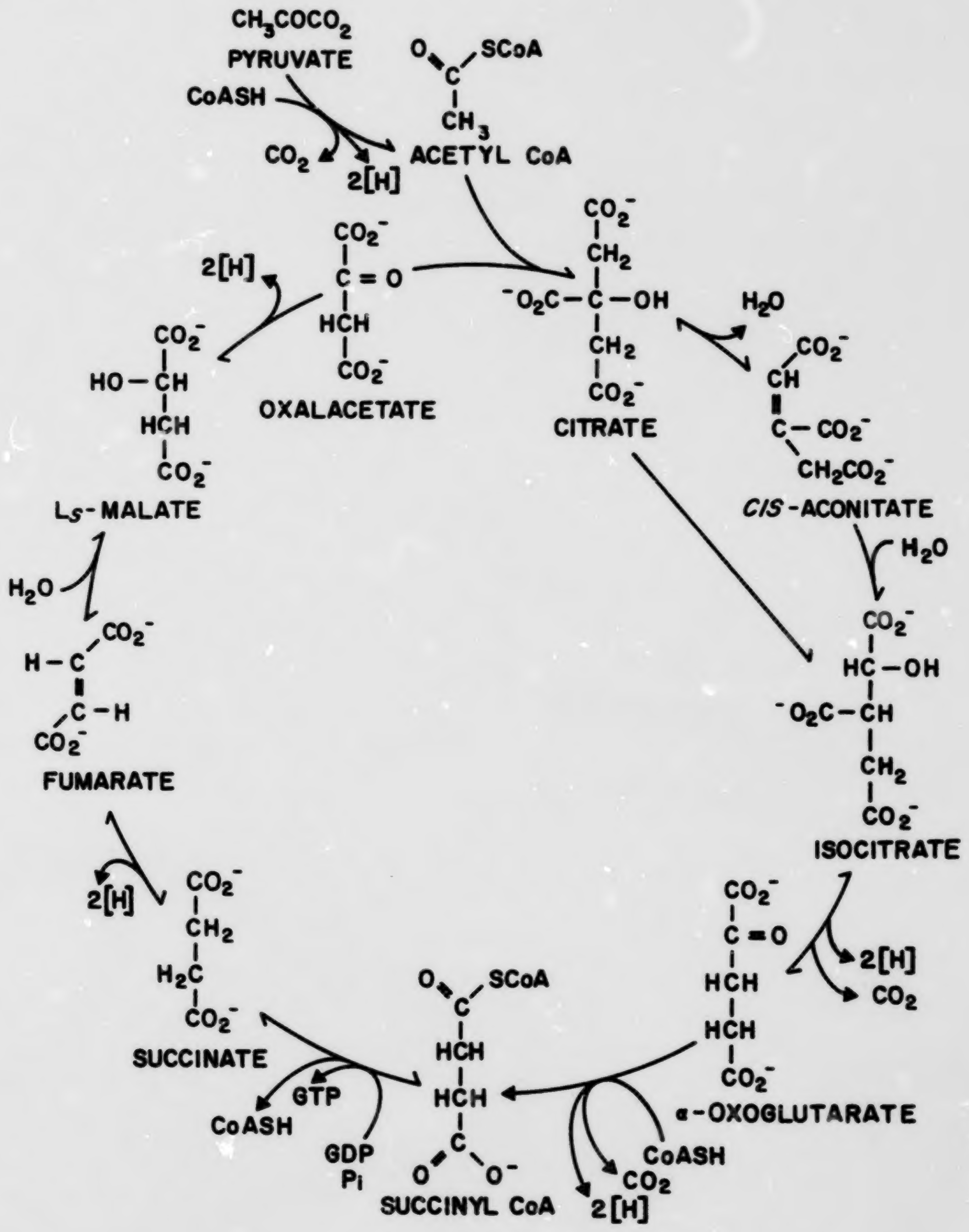

FIGURE 2·1

THE KREBS (CITRIC ACID) CYCLE

CH_3COCO_2
PYRUVATE
CoASH
CO_2
2[H]
ACETYL CoA
CITRATE
H_2O
CIS-ACONITATE
H_2O
ISOCITRATE
2[H]
CO_2
α-OXOGLUTARATE
CoASH
CO_2
2[H]
SUCCINYL CoA
GDP
Pi
GTP
CoASH
SUCCINATE
2[H]
FUMARATE
H_2O
L*s*-MALATE
2[H]
OXALACETATE

example) into biomass is very restricted and always requires the presence of carbon dioxide as the major carbon source. In fact, acetate, pyruvate and Krebs cycle acids are inhibitory to growth at concentrations ranging from 0.02 to 10 mmole. Artificial conditions, such as the selective removal of these acids in dialysis cultures (Borichewski and Umbreit 1966, Shafia and Wilkinson 1969) or adaptation techniques (Shafia and Wilkinson 1969), have allowed researchers to grow some strains of obligate chemolithotrophs on glucose. Neither the experimental procedures nor the outcomes have much relevance to conditions existing in pyritic tailings.

Bacteria which combine inorganic sources of energy and/or carbon with organics to support growth are referred to as facultative chemolithotrophs. Of the mesophilic thiobacilli, T. A2, T. acidophilus, T. intermedius, T. novellus, and T. perometabolis belong to this group (Matin 1978). Known strains of thermophilic sulphur oxidizing bacteria either benefit from or require low concentrations of organics (0.02 percent yeast extract) in the growth medium (Brock et al 1972).

Facultative chemolithotrophs are likely to encounter both inorganic and organic substrates simultaneously in nature; the growth and metabolism of these bacteria under mixotrophic conditions is of considerable interest. Mixotrophic growth conditions arise when both inorganic and organic substrates are supplied and are consumed by bacteria. Organisms such as T.intermedius, T. novellus, T. perometabolis (Matin 1978), the thermophiles including Sulfolobus (Brock et al 1972), iron oxidizing bacilli (Brierley and Lockwood 1977), and thiobacillus-type bacteria (Le Roux et al 1977) grow best when both inorganics and organics are present. Energy is derived from the simultaneous oxidation of both types of substrates, though the use of the inorganic fraction tends to be more directly growth associated. The fixation of carbon dioxide, however is greatly diminished under mixotropic growth conditions. Unlike obligate chemolithotrophic bacteria, these organisms preferentially use organic carbon sources for biosynthesis. Several facultative chemolithotrophic bacteria are unable to assimilate sulphate (Matin 1978), consequently, they require a supply of reduced sulphur compounds.

2.1.3 Role of Bacteria in Pyrite Oxidation

The exposure of pyritic materials to air and water leads to the development of characteristic microbial populations. Thiobacilli are the numerically predominant, but not exclusive, members of this community. Belly and Brock (1974) have observed high populations of acidophilic, heterotrophic yeast and fungi, and lower numbers of heterotrophic bacteria in pyritic coal refuse. Heterotrophic microorganisms use organic compounds as their carbon and energy source. Maximum microbial activity, as measured by carbon dioxide incorporation, occurred in 2 to 3 year old piles, while activity was substantially lower in fresh and 40-year-old material.

Heterotrophic microorganisms such as Streptomyces spp. and Arthrobacter spp. have also been reported to be capable of oxidizing reduced sulphide sulphur to sulphate (Ralph 1979). It is, however, doubtful that these oxidations yield metabolically useful energy and their net contribution to acidity may not be very significant (Nordstrom 1982).

Arkesteyn (1980) has studied the effect of pH on the development of stable microbial populations in an oxygen-limited chemostat with pyrite as the energy source. The chemostat is a fully controlled, stirred vessel for the continuous, steady state cultivation of microorganisms. At low pH (pH = 3.5), the obligate chemolithotrophs, T. ferrooxidans and T. thiooxidans were numerically predominant. In contrast, heterotrophic sulphur oxidizing bacteria, most likely thiobacilli, were the most numerous near neutral pH values. Soils artificially inoculated with T. thioparus, T. intermedius, and T. perometabolis, however, did not acidify faster than sterile controls in spite of a ten-fold increase in cell numbers. These observations suggest these bacteria may not play an important role in the acidification process.

Microbial populations are expected to vary seasonally. An approximately 5-fold enrichment in sulphur-oxidizing bacteria occurred in non-acidic coal spoils between April and July at a Montana mine site (Olson et al 1980).

The significance of iron bacteria (i.e. Gallionella, Leptothrix, Crenothrix, Cladothrix, etc.) in the microbial ecology of pyritic matter has been considered by several authors. These bacteria obtain energy by the oxidation of dissolved iron from the ferrous (Fe^{2+}) to the ferric (Fe^{3+}) state, but are unable to oxidize sulphur. Iron oxidizing bacteria are believed to be important, leading to the development of acidic conditions.

The acid tolerant bacterium, Metallogenum, has been discussed extensively in this regard; the organism has been isolated by Walsh and Mitchell (1972) from sulphidic coal and zinc mine drainages. Metallogenum grows in a pH range of 3.5 to 6.8 with either iron or organics as the energy source. High iron concentrations (100 $mg.L^{-1}$ Fe^{2+}) have been reported to be inhibitory (Walsh and Mitchell 1975). Accordingly, Walsh (1983) has suggested the deliberate increase of iron (Fe^{2+}) concentration in waste piles as a means of preventing the succession of bacteria, hence, pyrite oxidation.

Considering thermodynamics, Lundgren and Dean (1979) have cast some doubts concerning the oxidative metabolism of iron at pH values above 3.5. Since the bacterial oxidation of iron (Fe^{2+}) in solution consumes hydronium (hydrogen) ions, the free energy of ferrous to ferric oxidation declines with increasing pH. At higher pH values, the reaction is "driven" by the precipitation of ferric hydrate, which cannot produce metabolically usable energy. This would preclude the proliferation of Metallogenum in an environment with pyrite as the primary energy source. Other authors, notably Paciorek et al (1980) and Arkesteyn (1980), have failed to isolate Metallogenum from acidifying refuse.

2.1.4 Enumeration of Bacteria

The enumeration of sulphur- and iron-oxidizing bacteria and the measurement of activity are not without problems (Brierley 1978). Growth media developed by Hutchinson et al (1966, 1967 and 1969) for various sulphur oxidizers and the 9K medium of Silverman and Lundgren (1959a) for acidophilic iron oxidizers are still in use with some minor modifications. Since growth and colony formation on agar plates are often neither reliable nor reproducible, the traditional technique of enumeration has been the most probable number (MPN) method.

The MPN technique is based on dilution of the culture to produce a probable population density of less than one organism per aliquot and subsequent transfer of equal aliquots to test tubes (10 or more) containing sterile growth medium. Enumeration is based on the fraction of tubes showing some positive response (i.e. precipitation, colour change, pH change, etc.) after incubation. The propensity of many thiobacilli for attachment to solid surfaces (Beck and Brown 1968, McGoran et al 1969, Le Roux et al 1973, Brierley 1978, Ash 1979, Arkesteyn 1979, Myerson and Kline 1983, Goodman et al 1983) confounds the results, particularly, if the original sample contained solid particles. Yet, the technique has been applied, often indiscriminately, with surprising regularity (Brierley 1978). Although colony formation on membrane filters offers some advantages (Tuovinen and Kelly 1973), it has not been feasible to entirely eliminate the diffusion of toxic substances from the underlying agar layer. Automated techniques based on a Coulter counter or similar electronic apparatus have been hampered by the indiscriminate counting of bacteria and solid particles (Brierley 1978).

Perhaps the most promising technique for enumerating thiobacteria is the application of fluorescent antibody staining (Apel et al 1976, Brierley 1978). Immunoglobulin with specificity to T. ferrooxidans has been prepared by inoculating rabbits with inactivated cells and testing against 23 isolates. Immunoglobulins are double stranded, structurally related proteins in the blood plasma. Immunoglobulins include the antibodies. Antibodies are excreted by lymph cells in response to foreign proteins (antigens) in the blood. Physical binding of fluorescent antibody to the antigen is known as the immune reaction. Although non-specific, background fluorescence was a problem the immunogenic cross-reaction between unrelated species was slight. At the present time, the large-scale availability of specific immunoglobulins hinders the general application of these procedures.

A potential solution would be the application of monoclonal antibody (MA_b) production technology. Monoclonal antibodies (MA_b) are produced by an identical group of cells (monoclone) derived from a single mother cell. In contrast to immunoglobulins, MA_b consists of one kind of protein antibody only. Lymph cells producing MA_b against various sulphur- and iron-oxidizing bacteria could be generated by inoculating immature mice with the test organism. The fusion of the lymph cells with established mammalian cell lines results in hybrids (known as hybridomas) producing antibodies continuously.

2.1.5 Measurement of Bacterial Activity

Physicochemical measurements including pH decline, increase of titratable acidity, metal dissolution, sulphate accumulation, carbon dioxide fixation, oxygen utilization and particulate organic nitrogen (PON) content have been used for assessing bacterial activity. Since all of these measurements are subject to interference, none give an unambiguous measurement of bacterial function on pyrite. Changes in pH and acidity, metal dissolution, and sulphate formation involve both biological and non-biological reactions such as chemical oxidation, complexation, dissolution, and precipitation. Dissolved metal concentrations, for example, are often functions of environmental variables, which are only indirectly related to bacterial activity (e.g. pH).

Of the above parameters, sulphate formation is probably the most relevant to evaluate the net oxidation rate in tailings, yet, it has been reported rarely in comparison to dissolved metal values. The scarcity of sulphate measurements is probably due to the stated emphasis on metal leaching as well as the more convenient analytical techniques for evaluating dissolved metal concentrations. The advent of better designed analytical instruments for evaluating sulphate and other oxy-sulphur compounds, would solve this problem.

The interference of non-specific bacteria with the interpretation of carbon dioxide fixation, oxygen utilization and PON measurements is likely. The fixation of carbon dioxide and oxygen is by no means limited to sulphur-oxidizing bacteria. Unrelated, heterotrophic organisms are automatically included in measurements of PON. While these parameters serve a useful and important purpose under well defined, laboratory conditions involving known biota, their lack of specificity limits their usefulness in field investigations for evaluating the bacterial activity on sulphidic material.

2.2 Thiobacilli

2.2.1 Distinguishing Characteristics

The Thiobacillus genera comprise gram negative, rod shaped bacteria in the Order Pseudomonadales, Family Thiobacteriaceae (Breed et al 1977). Gram negativity refers to the staining characteristics (gram stain) of the bacterial cell surface. These bacteria are generally 1 to 2 μm long and 0.5 to 1.0 μm wide with very little morphological variation between genera. They occur singly, sometimes in pairs. Motility is variable. Motile strains usually possess a single, polar flagellum. The common metabolic feature is the ability to oxidize reduced sulphur compounds to sulphate. The type species is Thiobacillus thioparus. The relevant growth characteristics, nutritional requirements, and environmental conditions of the important species are discussed below.

2.2.2 Thiobacillus ferrooxidans

At mesophilic temperatures, this chemolithotroph occupies a pivotal position with regard to the biological transformation of iron and sulphur containing minerals. This ubiquitous member of the microbial community in acidic mine wastes was first isolated and described over thirty years ago (Colmer and Hinkle 1947, Temple and Colmer 1951). Various similar isolates cited as Ferrobacillus ferrooxidans and Ferrobacillus sulfooxidans in the early literature were proven to be identical with T. ferrooxidans in later studies (Hutchinson et al 1966 and 1969, Gale and Beck 1967). The nomenclature used by the original authors, however, has been retained in this report where applicable, i.e. *F. ferrooxidans*, *F. sulfooxidans*, or *T. ferrooxidans*. The bacterium is very versatile and has the ability to directly oxidize many chemical species, a characteristic which is unparallelled by any other thiobacillus (Bruynesteyn and Duncan 1970, Silver and Torma 1973, Sakaguchi et al 1976, Brierley 1978, Lundgren and Silver 1980). A listing of oxidizable species include ferrous ion (Fe^{2+}), sulphur (S°), thiosulphate ($S_2O_3^{2-}$), thionates, ($S_4O_6^{2-}$), arsenopyrite (FeAsS), bornite (Cu_5FeS_2), chalcocite (Cu_2S), chalcopyrite ($CuFeS_2$), covellite (CuS), energite ($CuAsS_4$), galena (PbS), greenockite (CdS), marcasite (FeS_2), millerite (NiS), molybdenite (MoS), pentladite ($(Fe,Ni)_9S_8$), pyrite (FeS_2), pyrrhotite (FeS), sphalerite (ZnS), stibnite (Sb_2S_3), sycoporite (CoS) and tetrahedrite ($(Cu,Fe)_{12} Sb_4 S_{13}$).

The optimal growth conditions for *T. ferrooxidans* have been outlined by Torma and Bosecker (1982). The relevant data are summarized in Table 2.2. The optimum temperature of autotrophically growing *T. ferrooxidans* has been reported to be 35°C. Viable cells above the optimum temperature have been observed in gradually declining numbers (Brierley and Lockwood 1977), although a few survivors, probably members of a thermotolerant strain, have been found in chalcopyrite leachate at temperatures as high as 60°C (Brierley 1980). Bacteria resembling *T. ferrooxidans* in their physiology and morphology have been described growing actively at 60°C by Le Roux et al (1977). Unlike *T. ferrooxidans*, however, these thermophilic thiobacilli required yeast extract in the medium.

The optimum pH depends on the type of substrate. Arkesteyn (1979) has found that only the biological oxidation of iron, as measured by oxygen uptake, peaked at pH values below 3.0. Pyrite

TABLE 2.2

Optimal Growth Conditions for T. ferrooxidans

Temperature		35°C
pH		2.3
Ferrous ion concentration		180 mmoles/L
Metal sulphide concentration		10 to 25 percent solids
Particle size		less than 35 μm
Nutrients:	NH_4^+	80 mmoles/L
	H_2PO_4	3 mmoles/L
	CO_2 (in air)	0.2 percent (v/v)
	O_2 (in air)	$\cong$ 21 percent (v/v)

oxidation proceeded optimally at pH values near 3.0, while a slight optimum in sulphur oxidation was observed between pH 4.0 and pH 5.0.

At pH values above 4.5, the rate of pyrite oxidation exceeded iron oxidation. Interestingly, elemental sulphur oxidation occurred at pH values as high as 7.0. Pyrite and iron grown cells gave virtually identical pH-dependent oxidation profiles. These results suggest that the pH optimality is a function of the substrate type as well as the particular strain of T. ferrooxidans (Lundgren and Silver 1980).

Direct enzymatic attack of pyritic ores is enhanced because T. ferrooxidans can adhere to the surface of the ore particles. Pili formation for lasting attachment has been reported in several strains of T. ferrooxidans (DiSpirito et al 1982), in others the attachment is chemical in nature (Wang and Lundgren 1968 and 1969). Both the iron-oxidizing enzymes (Sugio et al 1981a) and sulphur (sulphide) oxidizing enzymes (Suzuki 1974, Silver 1978) are imbedded in the cytoplasmic membrane, thus, adherence to pyrite greatly accelerates the oxidative processes. The excretion of phospholipids has been suggested to aid in the mass transfer across the solid/cell membrane boundary (Ralph 1979), although the additon of synthetic surfactants yielded contradictory results (Duncan et al 1964 and 1967, Kleinmann et al 1981). Sulphur oxidation has been found to be more pressure sensitive than iron oxidation. Davidson et al (1981) have reported that an appreciable decline in sulphur oxidation occurred at an hydraulic compression of 0.34 MPa, while iron oxidation was unaffected to 10 MPa.

The bacterium exhibits a requirement for sulphate during growth on either iron or pyrite (Lazaroff 1963, Tuovinen and Kelly 1973). The addition of phosphate has been reported to be beneficial (Beck and Shafia 1964), and phosphate together with arsenate could partially replace the sulphate demand (Ralph 1979). Monovalent anions including nitrate, flouride, and chloride are definitely inhibitory (Razzell and Trussell 1963a, Tuovinen et al 1971).

Thiobacillus ferrooxidans is unable to reduce nitrate for biosynthesis (Hutchinson et al 1969). Ammonium ion has been regarded as the primary nitrogen source by most researchers. In the absence of ammonia, the fixation of atmospheric nitrogen (i.e. reduction for protein synthesis) has been reported (Mackintosh 1976). The data on the significance of nitrogen fixation are inconclusive, since metal leaching rates have been found to be consistently higher when a known acid tolerant nitrogen fixing bacterium, notably Beijerinckia sp., has been artificially co-cultured with T. ferrooxidans (Trivedi and Tsuchia 1975).

Under autotrophic growth conditions, volatile fatty acids (Matin 1978), surfactants (Kleinmann et al 1981, Olem et al 1982), glucose (Silver et al 1967), acidic products of carbohydrate metabolism and other organic compounds (Matin 1978) have been reported to be highly inhibitory. Various strains of T. ferrooxidans could be adapted to grow on glucose (Shafia and Wilkinson 1969, Sugio et al 1981b) while maintaining acidophilic properties and iron oxidizing ability. However, not all strains are adaptable to organic nutrients (Silver 1978). The "adaptability" may have been due to the presence of closely related contaminants, such as T. acidophilus in the "pure culture".

The consensus of the scientific literature is that T. ferrooxidans is essentially an aerobic bacterium. The consumption of dissolved oxygen for the oxidation of ferrous iron

(Silverman and Lundgren 1959a and 1959b, Kelly et al 1977, Kelly and Jones 1978) and the oxidation of pyrite (Paciorek et al 1980) has been close to the stoichiometric requirement. This oxidation process proceeds to very low oxygen content in the liquid phase (Baker and Wilshire 1970a and 1970b, Myerson 1981) with either iron or pyrite as the substrate. While ferrous iron is the preferred electron donor for energy production, experimental evidence indicates that direct enzymatic oxidation of cuprous ion (Ralph 1979), and uranous ion (DiSpirito and Tuovinen 1982a) could also be coupled with oxygen in generating energy for growth. Under anaerobic conditions, *T. ferrooxidans* has been reported to use ferric ion (Fe^{3+}) in lieu of oxygen for the oxidation of sulphur to sulphate (Brock and Gustavson 1976). The presumed stoichiometry of this reaction is:

$$S^{\circ} + 6Fe^{3+} + 4H_2O \rightarrow SO_4^{2-} + 6Fe^{2+} + 8H^{+} \qquad (2.1)$$

The above reaction is energetically favourable and may have important implications for acid generation in tailings below the water table (Nordstrom 1982). However, the extent of the reaction, hence the growth of *T. ferrooxidans*, is limited by the availability of the ferric ion. Sustained growth under anaerobic conditions, as reported by Goodman et al (1983), remains to be substantiated.

In comparison to most other bacteria, the tolerance of *T. ferrooxidans* to toxic metal ions is remarkable. Various strains have been reported to tolerate 1 $mg.L^{-1}$ mercury, 50 to 100 $mg.L^{-1}$ selenium, tellurium, and arsenic anions (Brierley 1978), 200 $mg.L^{-1}$ silver (Sugio et al 1981c), 0.5 to 1.0 $g.L^{-1}$ uranyl and thorium ions (DiSpirito and Tuovinen 1982b), 2 $g.L^{-1}$ of molybdenum and 5 $g.L^{-1}$ of chromium (Lundgren and Silver 1980), 10 to 30 $g.L^{-1}$ of aluminum, cobalt, copper, manganese, and nickel (Lundgren and Dean 1979, Lundgren and Silver 1980) and from 70 to 120 $g.L^{-1}$ of zinc in solution (Torma et al 1970 and 1972). Although metal ion tolerance varies with the particular strain and environmental conditions, *T. ferrooxidans* possesses a well noted ability to adapt to increasingly higher metal levels with each successive transfer. Some evidence suggests that this adaptability is due to plasmids encoding proteins that render intracellular toxic metals inactive (Torma 1983). Plasmid Deoxyribonucleic Acid (DNA) has been found in 11 of 15 strains of *T. ferrooxidans* (Martin et al 1981). While plasmid was not detected in the other four, it may have been present.

In the microbial ecology of pyritic tailings and refuse piles, *T. ferrooxidans* exists with numerous other microbial species. Belly and Brock (1974) found heterotrophic yeasts and fungi in high numbers, and less numerous heterotrophic bacteria, cohabiting coal refuse with *T. ferrooxidans*. Highest population density occurred in the top 20 cm of coal spoils. Mutualistic interactions with other thiobacilli have been commonly observed. Although *T. ferrooxidans* is usually the numerically predominant member of the microbial community, *T. thiooxidans* (Arkesteyn 1980, Paciorek et al 1980, Torma and Bosecker 1982), *T. thioparus* (Olson et al 1980, Arkesteyn 1980) and *T acidophilus* (Guay and Silver 1975, Arkesteyn 1980) have been found in significant numbers coexisting with *T. ferrooxidans* in acidifying soils. The cooperative interaction between this microbial community has not been clearly delineated. It is significant in this regard, that co-cultures of *T. ferrooxidans* with *T. thiooxidans* have oxidized pyrite at a substantially faster rate than *T. ferrooxidans* alone (Wakao et al 1982). Bacterial attack of pyrite can give rise to the accumulation of elemental sulphur. *T. thiooxidans* appears to be a more efficient sulphur oxidizer than *T. ferrooxidans.*

2.2.3 *Thiobacillus thiooxidans*

This obligate chemolithotroph occurs in acidic sulphate soils together with *T. ferrooxidans* (Paciorek et al 1980, Arkesteyn 1980, Torma and Bosecker 1982). Morphologically, *T. thiooxidans* is virtually identical with *T. ferrooxidans*. The principal physiological difference between the two organisms is the inability of *T. thiooxidans* to oxidize ferrous iron. In a pyritic tailings environment, however, the ferric iron produced by *T. ferrooxidans* results in elemental sulfur formation on the pyrite surface by an abiological redox reaction as indicated below;

$$2Fe^{3+} + FeS_2 \rightarrow 3Fe^{2+} + 2S^\circ \qquad (2.2)$$

In a highly acidic environment, *T. thiooxidans* appears to be more efficient in oxidizing elemental sulphur than *T. ferrooxidans*. Sulfur oxidation at pH values of 0.5 and below characterizes *T. thiooxidans* as the most extreme acidophilic thiobacillus. The morphological similarity and the symbiotic association with *T. ferrooxidans* result in difficulties in microbiological differentiation between these two bacteria. The loss of sulfur oxidizing activity has been reported to occur at somewhat higher pressures than in the case of *T. ferrooxidans*.

Being an obligate chemolithotroph, the growth of *T. thiooxidans* is inhibited by various organic compounds (Marunouchi and Mori 1968, Matin 1978). Growth on glucose has required the continual replacement of medium to avoid accumulation of pyruvic acid (Borichewski and Umbreit 1966). Inhibition by light and UV light (Adair 1968, Le Roux and Marshall 1977) is similar to other chemolithotrophic thiobacilli, notably *T. ferrooxidans* and *T. thioparus*. *T. thiooxidans* has been observed to tolerate higher levels of monovalent anions (e.g. chloride, nitrate) than most other acidophilic thiobacilli (Hutchinson et al 1969).

The mutualistic cooperation between *T. thiooxidans* and *T. ferrooxidans* in oxidizing pyritic ores has been the subject of several reports. Although some workers have suggested that the oxidation of metal sulphides can be accomplished by pure cultures of *T. thiooxidans*, more recent experimental evidence indicates that pyrite is not attacked by *T. thiooxidans* alone (Paciorek et al 1980). Artificial co-cultures with *T. ferrooxidans*, however, have promoted the rapid growth of *T. thiooxidans* in pyritic medium.

2.2.4 Thiobacillus organoparus and Thiobacillus acidophilus

Thiobacillus organoparus was isolated from acidic mine drainage and oxidizing sulphide deposits in the USSR (Brierley 1978). A very similar bacterium, *T. acidophilus* was first described by Guay and Silver (1975). This facultative chemolithotroph was isolated from a "pure" *T. ferrooxidans* culture after four transfers in glucose enriched medium. Optimum growth was observed at 25 to 30°C and pH 3.0, although growth occurred from pH 1.5 to pH 6.0. *T. acidophilus* could use elemental sulphur as well as various hexoses, pentoses, sugar alcohols, Krebs cycle acids, and amino acids (aspartic, glutamic) as energy sources. Thiosulphate and iron were not oxidized. Apparently, *T. acidophilus* is a strict aerobe. The bacterium cannot reduce nitrate and uses ammonia as the sole source of nitrogen for biosynthesis. In an organic medium, *T. acidophilus* resembled glucose-adapted *T. ferrooxidans*. Unlike *T. ferrooxidans*, however, *T. acidophilus* could be readily transferred from heterotrophic to autotrophic conditions without loss of activity.

Tuovinen et al (1978) reported different results with *T. acidophilus*. In their hands, this bacterium grew autotrophically on thiosulphate, ferrous ion, and tetrathionate as well as on elemental sulphur. Glucose-grown cultures retained their ability to oxidize iron as well as sulphur compounds. The authors reasoned, that this adaptability is due to a tightly coupled, heterogeneous T. ferrooxidans and T. acidophilus population, that cannot be readily separated by conventional microbiological techniques. Iron enriched conditions may give selective growth advantage to the former, and organics to the latter, but neither is completely eliminated upon subculture in a particular medium.

Recent evidence concerning the occurrence of plasmids (small, extranuclear DNA) in various T. acidophilus and T. ferrooxidans strains (Martin et al 1981) could explain some of the interactions between these species. Plasmids provide a means of transferring genetic information and allow unusual adaptations. At the present, the genome (genetic composition) of thiobacilli has not been mapped. One may speculate, that functions such as metal tolerance (Torma 1983) and perhaps tolerance to organics are encoded on plasmids. The fortuitous transfer of genetic information via plasmid vectors could give rise to mixed populations with unique characteristics that may vary from one culture to another.

2.2.5 Thiobacillus thioparus and Thiobacillus neapolitanus

These species differ mainly in the ability of T. thioparus to oxidize thiocyanate (Hutchinson et al 1969). Bacteria formerly named T. thiocyanoxidans are now regarded as strains of T. thioparus. Both species oxidize thiosulphate and sulphur under aerobic conditions.

Being essentially obligate chemolithotrophic bacteria, they are inhibited by various organic compounds, particularly carboxylic acids. The cell yield, however, was observed to be increased somewhat by low concentrations (1 mmole) of succinate or acetate in chemostat cultures of T. neapolitanus (Matin 1978) The incorporation of amino acids into cell protein has been very limited, although T. thioparus has apparently been found to benefit from valine in the growth medium. Valine is an amino acid constituent of proteins. Whole cells need reduced sulphur compounds and dissolved carbon dioxide (as bicarbonate) for the assimilation of these amino acids (Matin 1978). Although primarily an aerobe, T. thioparus is capable of limited growth anaerobically (i.e. in an oxygen free environment) in thiosulphate-nitrate medium. Unlike T. denitrificans, indefinite exposure to anaerobic conditions has been found to cause a die-out of this organism (Hutchinson et al 1969).

T. thioparus and T. neapolitanus prefer near neutral to slightly alkaline pH conditions. The growth rates are reduced below pH 5.0; at pH of about 3.0 the organisms stop growing altogether. Their significance with regard to pyritic wastes may be the initial development of acidic conditions. The occurrence of T. thioparus in mixed culture with other thiobacilli has been reported in coal spoils (Olson et al 1980), pyritic soils (Arkesteyn 1980), and sulphidic deposits (Ralph 1979). Their net contribution to acidification, however, remains obscure.

2.2.6 Thiobacillus novellus and Thiobacillus A2

These facultative chemolithotrophs oxidize thiosulphate to sulphate in a near neutral (pH 6.0) to alkaline (pH 9.5) environment. The growth characteristics of both organisms have been described by Taylor and Hoare (1969). The use of nitrate as a terminal electron acceptor in anaerobic cultures of heterotrophically grown Thiobacillus A2 has been noted as a major difference between the two species. In addition, a wider range of organic compounds (aromatics, for example) and thionates supported the growth of Thiobacillus A2. Both organisms could be transferred from autotrophic to heterotrophic media, and visa versa, with little difficulty.

As they are easy to cultivate and grow fast, these organisms have been actively studied with regard to the regulation of enzymes involved in carbon dioxide fixation and sulphur metabolism (Suzuki 1974, Matin 1978, Charles et al 1984). In a mixotrophic environment, T. novellus concurrently used glucose and thiosulphate, but the growth rate was lower than in heterotrophic cultures (Perez and Matin 1980). Thiosulphate and sulfite, in fact, inhibited both glucose transport and glucose metabolism (Matin et al 1980).

Nothing is known about their occurrence and function in pyritic soils. Due to their restrictive pH requirements for growth and the metobolism of only water soluble oxy-sulphur compounds, their activity would be significant only in unusual situations.

2.2.7 Thiobacillus intermedius

The facultative chemolithotroph, T. intermedius was first described by London (1963). This bacterium fills an ecological niche between facultative organisms preferring an alkaline environment (e.g. T. novellus) and the acidophilic species (e.g. T. acidophilus). The combination of acid tolerance to pH 2.0 and the facultative nature of these bacteria was considered to be unusual in the earlier literature (Hutchinson et al 1969).

Under mixotrophic conditions, T. intermedius can grow in a very simple organic environment consisting of a single carbon source (citrate, glucose) and reduced sulphur for both energy and biosynthesis. The inability of the bacterium to reduce sulphate for assimilation has been noted (Matin 1978).

The role of *T. intermedius* in acidifying mine tailings has not been established. Although *T. intermedius* strains have been isolated from pyritic coal spoils (Olson et al 1980), *T intermedius* has been found to be ineffective in enhancing pyrite oxidation in mixed culture with other thiobacilli (Arkesteyn 1980).

2.2.8 *Thiobacillus denitrificans*

This is the only chemolithotroph whose capability of sustained growth on inorganic sulphur compounds under both aerobic and anaerobic conditions is thoroughly documented. Under anaerobic conditions, *Thiobacillus denitrificans* use nitrate as the electron acceptor. Sulphur, thiosulphate, and thiocyanate have been reported to be oxidized to sulphate with the concomittant reduction of nitrate to nitrogen gas (Hutchinson et al 1969, Taylor et al 1971). The optimum pH for growth has been reported to be about 7.0, while pH values below 5.0 are inhibitory. Under anaerobic conditions the net production of acid is slight due to nitrate reduction accompanying sulphur oxidation:

$$5S^{o} + 2H_2O + 6NO_3^- \rightarrow 5SO_4^{2-} + 3N_2 + 4H^+ \qquad (2.3)$$

In an aerobic environment, however, the pH drops rapidly to unfavourable levels (below 5.0), where growth stops. This explains early reports of the strictly anaerobic character of this organism. Being an obligate chemolithotroph, the growth of *T. denitrificans* is inhibited by a variety of organic compounds including formate, acetate pyruvate, oxalate, and Krebs cycle intermediates (Matin 1978).

The growth kinetics of *T. denitrificans* in anaerobic and aerobic chemostat culture has been studied by Justin and Kelly (1978a). The organism grew rapidly under both aerobic (maximum specific growth rate = 0.14 hr^{-1}) and anaerobic (maximum specific growth rate = 0.09 hr^{-1}) environments with thiosulphate as the limiting substrate. The growth yields in aerobic (14.7 g biomass.mol^{-1} thiosulphate) and in anaerobic (11.5 g biomass.mol^{-1} thiosulphate) nitrate limited cultures were substantially higher than the yields reported for T. neapolitanus, T. ferrooxidans and T.A2 under aerobic conditions. The authors have suggested a more efficient energy (ATP) coupling mechanism for this facultative anaerobic thiobacillus (Justin and Kelly 1978b).

Uranium mine tailings contain nitrate which originates from the mining and milling operations. Assuming the tailings are eventually vegetated the growth-decay cycle would provide a natural and continuous source of nitrate. The simultaneous presence of nitrate and reduced sulphur at near neutral pH provides an ideal environment for T. denitrificans. Denitrification by this thiobacillus would explain the observed reduction of nitrate with depth in uranium tailings porewater (Golder and SENES 1982). To date, no attempt has been made to isolate T. denitrificans from tailings porewaters.

2.2.9 Thiobacillus perometabolis

Thiobacillus perometabolis was first described by London and Rittenberg (1967). Its principal characteristics, obligate mixotrophy, results from its inability to grow autotrophically. Elemental sulphur, thiosulphate, and tetrathionate are rapidly oxidized to sulphate if organic substrates (pentoses, hexoses, amino acids) are present simultaneously with reduced sulphur compounds. Apparently, the organism is unable to fix carbon dioxide as its carbon source. In addition, T. perometabolis cannot assimilate nitrate (NO_3^-) or sulphate (SO_4^{2-}) for protein synthesis (Matin 1978). This bacterium is strictly aerobic with oxygen being the only known electron acceptor.

The bacterium grows optimally at 30°C with a relatively short generation time of 3.5 hours in thiosulphate medium (London and Rittenberg 1967). Although the optimum pH is near neutrality, growth and sulphur oxidation have been reported to occur to pH 2.8. Thus the presence of T. perometabolis in acid mine drainage water is likely, particularly, if organics are present. Low numbers (10 to 100 cells.ml^{-1}) of heterotrophic sulphur oxidizing bacteria resembling T. perometabolis have been isolated from coal mine drainage by Myers and Millar (1975). Alkaline strip mine spoils contained higher numbers of mixotrophic bacteria, but identification of the individual species was not attempted (Olson et al 1980). Arkesteyn (1980) demonstrated the growth of T. perometabolis in acidifying soils containing pyrite, but the bacterial contribution to the acidity level was insignificant.

2.2.10 Metallogenium

The term, "iron bacteria" has been used historically to describe microorganisms that precipitate ferric hydroxide ($Fe(OH)_3$) from iron-bearing solutions. A few members of this diverse group, such as Gallionella, Leptothrix, Siderocapsa, and Metallogenium derive metabolically useful energy from iron oxidation (Lundgren and Dean 1979). Acid tolerant strains of Metallogenium have been receiving the most attention with respect to acidifying tailings.

This acid-tolerant, filamentous iron bacterium has been isolated from coal mine waters by Walsh and Mitchell (1972). Metallogenium catalyzes iron oxidation in the pH range from 3.5 to 4.5. As indicated by Apel and Dugan (1978), iron oxidation per se does not give rise to acid (hydrogen ion) generation. In fact, the oxidation process consumes hydrogen ions:

$$2Fe^{2+} + 2H^{+} + 0.5O_2 \rightarrow 2Fe^{3+} + H_2O \qquad (2.4)$$

However, the precipitation of ferric ion as ferric hydroxide gives rise to net acidity:

$$Fe^{+3} + 3H_2O \rightarrow Fe(OH)_3(s) + 3H^+ \qquad (2.5)$$

Walsh and Mitchell (1975) reasoned that the substrate inhibition of the iron oxidation by Metallogenium by ferrous ion concentrations as low as 100 $mg.L^{-1}$ could prevent the development of acid conditions favourable for the growth of T. ferrooxidans. This concept of tailings management, however, is negated by the ability of T. ferrooxidans to oxidize the sulphide moiety of pyrite at significant rates at pH values above 3.5 (Arkesteyn 1979). Furthermore, other investigators, notably Arkesteyn (1979) and Paciorek et al (1980) have been unable to isolate any bacterium resembling Metallogenium from acidifying pyrite soils. These results, together with thermodynamic limitations on generating metabolically useful energy from iron oxidation at pH values above 3.5 (Lundgren and Dean 1979) question the role of Metallogenium in the pH-dependent succession of bacteria in pyritic tailings.

2.2.11 Sulfulobus acidocaldarus, Thermoplasma acidophilus

The thermophilic, sulphur and iron oxidizing bacterium, Sulfolobus acidocaldarus was isolated from hot springs and acid thermal soils by Brock et al (1972). Unlike the thiobacilli, this acidophilic sulphur oxidizer is more or less spherical in shape and grows at a temperature range of 55°C to 90°C. Most strains oxidize sulphur between pH values of 1.0 to 5.9, the optimum being from pH 2.0 to pH 3.0. Sulfolobus acidocaldarus benefits from the presence of organics such as yeast extract, tryptophane, peptone, and casein in the medium. In contrast, the closely related species, Thermoplasma, requires organic compounds during sulphur oxidation and grows at somewhat lower temperatures (37 to 65°C) and pH range (0.5 to 4.3) than Sulfolobus.

During oxidation of sulphur compounds, Sulfolobus acidocaldarus attaches to solids (Weiss 1973, Bohlool and Brock 1974). The formation of pili aids in the attachment process (Brierley 1978). In the absence of organics in the medium , pili formation does not take place, hence, both adherence to solids and sulphur oxidation are less effective (Weiss 1973).

The doubling time of Sulfolobus is 30 to 40 hours (Mosser et al 1973). Different strains appear to have different temperature optima ranging from 65 to 80°C. Strains growing at lower temperature (50 to 60°C) coexist with thermotolerant forms of T. ferrooxidans. Under anoxic conditions, Sulfolobus may use hexavalent molybdenum as the electron acceptor, in a manner similar to the use of ferric ion, by T. ferrooxidans, for the oxidation of sulphur compounds to sulphate (Brierley and Murr 1973, Brierley 1978). The oxidation rates of copper minerals such as chalcopyrite ores have been reported to be higher when both Sulfolobus and T. ferrooxidans coexisted in the same leach column (Brierley 1980).

At temperatures above 55°C, the physiology of Sulfolobus is similar to T. ferrooxidans growing at lower temperatures. The inherently faster growth rates in the thermophilic temperature range would result in a faster rate of pyrite oxidation. However, there is no evidence, that tailings in the temperate climatic zone have developed high enough temperatures for colonization by Sulfolobus.

2.3 Bacterial Mechanisms in Pyrite Oxidation

2.3.1 Mechanism of Iron Oxidation

In nature, divalent (ferrous) iron minerals such as carbonates (siderite), sulphates (melanterite, rozenite, szomolnokite), and sulphides (pyrrhotite, marcasite, pyrite) are unstable when exposed to atmospheric oxygen and moisture. The oxidation of the ferrous iron to the ferric (trivalent) state occurs in the water phase enveloping the mineral surface. Dissolved oxygen in the water serves as the oxidizing agent. The non-biological oxidation process has been the subject of numerous studies and its relevance to biological oxidation has been reviewed recently by Nordstrom (1982). The reaction consists of a series of elementary steps involving one electron transfer from Fe^{2+} to oxygen as summarized below:

$$Fe^{2+} \rightarrow Fe^{3+} + e^- \qquad (2.6)$$

$$O_2 + e^- \rightarrow O_2^- \qquad (2.7)$$

$$O_2^- + 2H^+ + e^- \rightarrow H_2O_2 \qquad (2.8)$$

$$H_2O_2 \rightarrow H_2O + 0.5O_2 \qquad (2.9)$$

The rate limiting step at pH values above 4.0 is the formation of hydrogen peroxide (equation 2.8), while at lower pH's the reaction rate is not a strong function of the hydrogen ion concentration and electron transfer to dissolved oxygen (equation 2.7) appears to be rate limiting. The kinetic model derived by applying the law of mass action is as follows (Nordstrom 1982):

$$\frac{d[Fe^{3+}]}{dt} = k\,\frac{[Fe^{2+}][O_2]}{[H^+]^2} \qquad (2.10)$$

Equation (2.10) is applicable for dissolved ferrous ion concentrations. At constant oxygen tension and pH (i.e. hydrogen

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ion concentration) the reaction is first order, the half life of the ferrous ion being approximately 1 minute at pH values near neutrality and in excess of 3 years at pH values below 4.0 (Stumm and Morgan 1981). It is the inherent slowness of the abiological reaction at acidic pH values that allows the biochemical coupling with enzymes to produce metabolically useful energy.

The ability of bacteria to catalyze the oxidation of iron for growth has been known since the turn of the century. Detailed physiological studies, however, could be initiated only after the development of suitable medium to cultivate iron oxidizing bacteria (Leathen et al 1951 and 1956, Silverman and Lundgren 1959a).

The energetics of iron oxidation by T. ferrooxidans and other iron bacteria has been assessed by Lees et al (1968), Kelly and Jones (1978), Silver (1978), and Lundgren and Dean (1979). It appears, that iron is a marginal energy source for biosynthesis. In biological systems, the biosynthetic energy requirement is usually expressed in terms of energy for the oxidative phosphorylation of adenosine diphosphate (ADP) to adenosine triphosphate (ATP) and referred to as ATP-equivalent. Under physiological conditions, an ATP equivalent corresponds to a free energy (G) of reaction of -40 $KJ.mol^{-1}$ to -50 $KJ.mol^{-1}$. It is clear that the free energy yield from the non-biological iron oxidizing mechanism which ranges from -25 $KJ.mol^{-1}$ at pH 3.0 to -32 $KJ.mol^{-1}$ at pH 1.5 (Lundgren and Dean 1979), falls short of this requirement. The complexing of ferrous ion with the cytochrome transport chain, however, allows two electron transfers to oxygen (Silver 1978) as indicated by the following half reactions:

$$2Fe^{2+} \rightarrow 2Fe^{3+} + 2e^- \quad (2.11)$$

$$2H^+ + 0.5O_2 + 2e^- \rightarrow H_2O \quad (2.12)$$

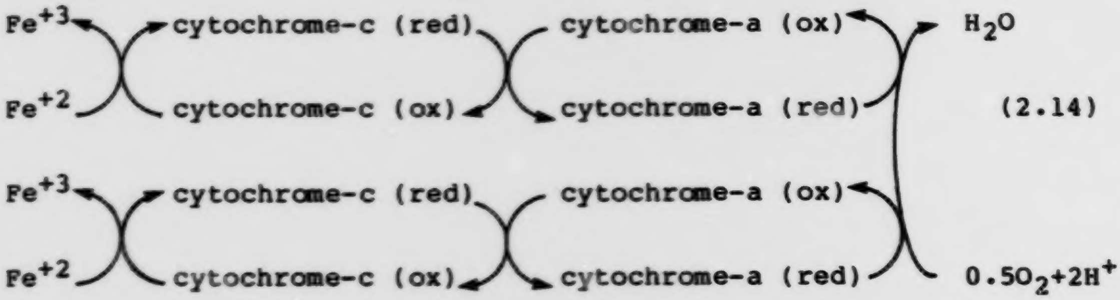
The free energy gained by coupling equations (2.11) and (2.12) can be expressed by the following equation:

$$\Delta G^{o}_{pH} = -88.6 + 11.4 \text{ pH} \qquad (2.13)$$

where ΔG^{o}_{pH} = pH - dependent free energy (KJ/mole)

According to equation (2.13), this electron transport via cytochromes would permit metabolically useful energy generation to pH values of approximately 4.0. Although the reaction proceeds at higher pH values, the driving force of the reaction becomes the precipitation of the ferric ion product as ferric hydroxide from which no useful biochemical energy is gained (Lundgren and Dean 1979).

Enzyme kinetic models of iron oxidation by whole bacterial cells (Wong et al 1974, Kelly and Jones 1978, Theis et al 1982) are consistent with a cytochrome-based oxidative mechanism. The entire set of enzymes (cytochrome oxidoreductases) and cofactors (coenzyme Q, cytochrome-c, cytochrome-a, and regulators) are localized in cytoplasmic membrane (Suzuki 1974, Summers and Silver 1978, Silver 1978, Sugio et al 1981a). The transfer of electrons from the ferrous ion via cytochromes to oxygen has been summarized by Tikonova et al (1967) and Silver (1978) as follows:


Fe^{+3}
Fe^{+2}
cytochrome-c (red)
cytochrome-c (ox)
cytochrome-a (ox)
cytochrome-a (red)
H_2O
Fe^{+3}
Fe^{+2}
cytochrome-c (red)
cytochrome-c (ox)
cytochrome-a (ox)
cytochrome-a (red)
$0.5O_2+2H^+$

(2.14)

The key enzyme, cytochrome-c oxidoreductase, from *T. ferrooxidans* has been purified and characterized by several investigators. The kinetic mechanism involves a reaction scheme (Silver 1978) requiring two reactants (Fe^{2+} and cytochrome-c (Fe^{3+})) and two products (Fe^{3+} and cytochrome-c (Fe^{2+})). Sugio et al (1981a) have found that the iron oxidizing activity is regulated by two proteins, one stimulating and one inhibiting iron oxidation. During the oxidation process, hydrogen ion is consumed as indicated by an initial pH rise of $FeSO_4$ grown *T. ferrooxidans* (Apel and Dugan 1978). The simultaneous uptake of two electrons (via cytochromes) and two protons (i.e. H^+) have been proposed to maintain electric neutrality.

The fate of the oxidized iron product (Fe^{3+}) is important from both the microbiological and the geochemical point of view. Ferric ion accumulating in the liquid medium has been found to inhibit microbial oxidation (Wong et al 1974, Kelly and Jones 1978). In addition, the ferric ion concentration eventually exceeds the saturation concentration and precipitates as a solid ferric hydroxide. Ivarson et al (1982) have observed from crystallographic data that this secondary mineralization is independent of bacterial presence inasmuch as the same mineral formations have been observed with or without bacterial activity. At pH values above 3.0, ferric hydroxide has been the most common precipitate. Physico-chemical properties such as solubility, porosity, and surface area of these ferric hydroxides have varied with time as the precipitates age (Langmuir and Whittemore 1970, Crosby et al 1983). At pH values below 3.0, ferric iron could precipitate as basic ferric sulphates, known as jarosites. According to Ivarson et al (1982), the formation of jarosite ($KFe_3(SO_4)_2(OH)_6$) proceeds according to the following reaction:

$$3Fe_2(SO_4)_3 + 0.5\ O_2 + 11\ H_2O + 2K^+ \rightarrow 2KFe_3(SO_4)_2(OH)_6 + 5H_2SO_4 \qquad .....(2.15)$$

Although jarosite formation is favoured, at low potassium (K^+) ion concentrations mineralization as ammoniojarosite ($NH_4Fe_3(SO_4)_2(OH)_6$) and natrojarosite ($NaFe_3(SO_4)_2(OH)_6$) has occurred in descending order. In uranium tailings divalent cations such as calcium and magnesium have not given rise to jarosite formation. This would diminish the probability of barium and radium jarosite precipitation as well, although the latter has not been proven experimentally. In arid climates, copiapite ($Fe^{2+}Fe_4^{3+}(SO_4)_6(OH)_2 \cdot 20H_2O$) has been the most common precipitate (Nordstrom 1982). There is no evidence of copiapite formation in pyritic tailings in Canada.

2.3.2 Mechanism of Sulphur Oxidation

The microbial oxidation of the sulphur moiety of metal sulphides, oxy-sulphur derivatives (thiosulphates, thionates) and elemental sulphur is of great significance in the geochemical transformation of sulphidic minerals. Although a number of microorganisms are known to oxidize reduced sulphur compounds, the thiobacilli and the metabolically related, thermophilic Sulfolobus and Thermoplasma species are unique in their ability to generate metabolically useful energy during this oxidation process. Most metal sulphides and elemental sulphur are highly insoluble in water. Because bacteria require that the substrate be in a dissolved state, the mechanism of attack of solid minerals has been reviewed in numerous studies (Parker and Prisk 1953, Ivanov et al 1961, Silverman et al 1963, Silverman 1967, Beck 1967, Beck and Brown 1968, Smith and Shumate 1970, Dugan and Randles 1971, Lundgren 1971, Nielsen and Beck 1972, Silver and Torma 1973 and 1974, Boorman and Watson 1976, Brierley 1978, Silver 1978, Ralph 1979, Trudinger 1979, Lundgren and Silver 1980, Torma and Bosecker 1982, Torma 1983, Torma and Banhegyi 1984). Considerable controversy has been noted about the role of microorganisms in the dissolution process. In many cases, enzyme catalyzed reactions have not been found to be distinguishable from simultaneous, parallel, non-biological events.

Most authors have chosen to distinguish between indirect and direct contact mechanisms of metal sulphide oxidation. The indirect mechanism involves the ferric ion as the oxidizing agent acting upon a metal sulphide (MS) as follows:

$$2Fe^{3+} + MS \rightarrow 2Fe^{2+} + M^{2+} + S^{\circ} \qquad (2.16)$$

Reaction (2.16) is believed to be non-biological, however, iron-oxidizing bacteria such as T. ferrooxidans catalyzes the cyclic re-oxidation of ferrous ion (Fe^{2+}) to the ferric (Fe^{3+}) state. Evidence for this indirect mechanism has been provided by observed higher dissolution rates when dissolved iron is added to bacterial leaching solutions containing MoS_2, ZnS, CdS, and $CuFeS_2$ (Ivanov et al 1961, Tributsch and Bennett 1981a). The indirect contact mechanism appears to be significant during the early stages of the leaching process. In the presence of T. ferrooxidans, the dissolution of copper from covellite and chalcopyrite in iron-containing leach liquor occurs in two distinct steps (Imai 1978, Wadsworth 1981, Scharer and Ibbotson 1982). Initially, T. ferrooxidans activity is largely confined to the oxidation of ferrous iron to the ferric state. During this phase, copper is dissolved by abiological means. As a sulphur-rich layer develops on the surface of the solids, the reduced iron (Fe^{2+}) pool becomes exhausted and further dissolution requires direct bacterial oxidation of the sulphur-rich layer.

The direct contact mechanism involves enzymatic oxidation of sulphide ores by contact between the bacteria and the ore surface. Initial evidence for the direct contact mechanism has been the often quoted tenacity of thiobacilli to attach to pyritic surfaces, although at low pH values (pH $\leq$ 1.5) the attachment has not given rise to improved oxidation rates (DiSpirito et al 1981). More concrete evidence for the direct contact mechanism has been the demonstrated bacterial oxidation of synthetic, non-ferrous sulphides in the absence of iron (Duncan et al 1967, Torma et al 1970, Nielsen and Beck 1972, Silver and Torma 1973 and 1974). Among others, Corrick and Sutton (1968) have shown that the beneficial effect of iron on non-ferrous metal sulphide oxidation diminished in long-term leaching. Arkesteyn (1979) has demonstrated the importance of direct contact by observing that the physical separation of *T. ferrooxidans* and pyrite by a dialysis membrane reduces the rate of pyrite oxidation from 12 percent for sulphur-grown cells to 75 percent for iron-grown cells. Furthermore, a selective inhibitor of sulphur oxidation, NEM, did not inhibit pyrite oxidation in an experiment where the bacterial culture was separated from the pyrite and inhibitor by a dialysis bag (indirect contact mechanism). The mass transfer between the ore and the cytoplasmic membrane is believed to be facilitated by phospholipids in the bacterial envelope surrounding the cell (Starkey et al 1956, Lundgren 1971, Ralph 1979).

Tributsch and Bennett (1982a and 1981b) have argued that, due to the large energy gap between metal sulphides (ZnS and CdS, for example) and known respiratory redox couples, the initial step in direct contact mechanisms cannot involve electron transfer. Rather, the sulphide mineral is protonated to yield hydrogen sulphide (H_2S) as follows:

$$MS(s) + 2H^+ \rightarrow M^{2+} + H_2S \qquad (2.17)$$

In contrast to equation (2.16), equation (2.17) does not involve electron transfer, since the oxidation states of the reactants have not changed. Thus, the initial step is governed by a solubility product (K_{so}) defined as follows:

$$K_{so} = \frac{[H_2S][M^{2+}]}{[H^+]^2} \qquad (2.18)$$

The ability of bacterial cell components to facilitate this dissolution process has not been conclusively demonstrated. Independent observations by Tributsch and Bennett (1981a) and Torma and Banhegyi (1984) that the oxidation of non-ferrous metal sulphides increases with the magnitude of the solubility product have lent considerable credence to this hypothesis and suggest that the availability of H_2S (or its dissociation products, HS^-, S^{2-}) is the rate-limiting factor. The solubility equilibrium favours the solid (MS) state. The driving force in the forward direction is provided by the further oxidation of hydrogen sulphide as indicated below (Tributsch and Bennett 1981a):

$$H_2S + 0.5O_2 \rightarrow H_2O + S^\circ \qquad (2.19)$$

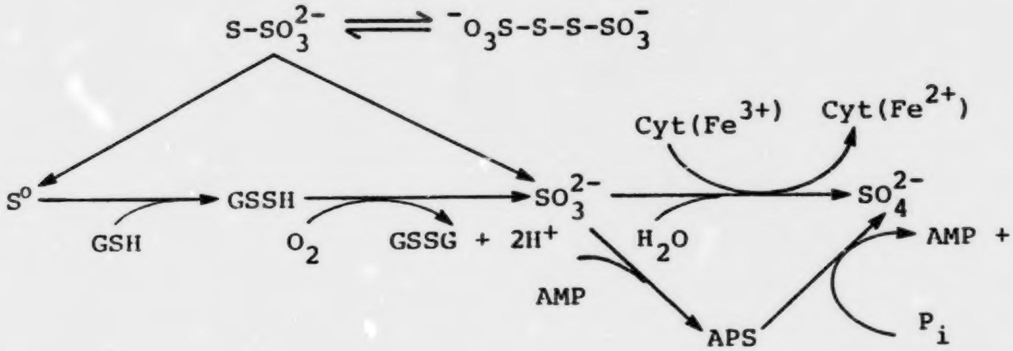
$$H_2S + H_2SO_4 \rightarrow H_2SO_3 + S^\circ \qquad (2.20)$$

Of the above reactions, equation (2.19) is energetically favoured and has been observed to proceed at reasonable rates non-biologically (Case et al 1979). Reaction (2.20) is probably restricted to biological systems. The coupling of reaction (2.20) with reduced glutathione (GSH), would eliminate significant accumulation of elemental sulphur as has been observed during the action of T. ferrooxidans on pyrite (Silverman 1967):

$$H_2S + H_2SO_4 + GSH \rightarrow H_2SO_3 + GSSH \qquad (2.21)$$

Both H_2SO_3 and GSSH are known intermediates of sulphur metabolism (Suzuki 1974, Silver 1978). Thus, the initial steps of metal sulphide oxidation by either direct or indirect contact give rise to components of sulphur metabolism. Biochemical energy is generated by further oxidation of these intermediates.

The mechanism of sulphur oxidation by bacteria may be summarized as follows (Kelly 1968, Suzuki 1974, Silver 1978, Ralph 1979):



...(2.22)

The entire sulphur oxidizing system is localized in the cytoplasmic membrane from which the various enzymes have been isolated and studied in vitro (Suzuki and Silver 1966, Charles and Suzuki 1966, Adair 1968, Tano and Imai 1968, Tano et al 1968, Taylor 1968, Silver and Lundgren 1968, Lyric and Suzuki 1970a and 1970c, Suzuki 1974). The mass transfer of sulphur to the membrane is probably mediated by the lipoprotein and lipopolysaccharide fractions in the cell envelope that render elemental sulphur more soluble by complexation (Silver 1978, Ralph 1979). In most aerobically growing thiobacilli, the oxidation sequence is initiated by reaction with the coenzyme, reduced glutathione (GSH), to form an organic polysulphide (Charles and Suzuki 1966, Suzuki 1974, Silver 1978):

$$S_8 + GSH \rightarrow GS_8SH \qquad (2.23)$$

The reaction of the sulphur-glutathione complex with oxygen is catalyzed by an oxygenase enzyme as indicated by the following reaction:

$$GS_8SH + O_2 + H_2O \rightarrow GS_8H + SO_3^{2-} + 2H^+ \qquad (2.24)$$

In some species, notably *T. neapolitanus* and *T. thiooxidans* (Taylor 1968), sulfite (SO_3^{2-}) formation has been reported to proceed without the glutothione polysulphi - intermediate. In either case, the reaction is energetically favoured and characterized by a large free energy change. Enzymatic reactions involving oxygenation, however, are not coupled with oxidative phosphorylation, consequently no metabolic energy can be generated by equation (2.24).

In energy production for biosynthesis, sulfite represents a key intermediate. The oxidation of sulphite to sulphate involves two electron transports via the cytochrome system as illustrated below (Silver 1978):

$$SO_3^{2-} + H_2O + cyt"c"(Fe^{3+}) \xrightarrow{ADP+P_i \quad ATP} SO^{2-} + H^+ + cyt"c"\ (Fe^{2+}) \qquad (2.25)$$

In aerobic thiobacilli, oxygen serves as the terminal electron acceptor. The electron transport to oxygen is catalyzed by a cytochrome oxidoreductase as follows:

$$cyt"a"\ (Fe^{2+}) + H^+ + 0.5O_2 \rightarrow cyt"a"\ (Fe^{3+}) + H_2O \qquad (2.26)$$

Facultatively aerobic thiobacilli such as *T. denitrificans* and *T. thioparus* obtain energy (ATP) via the formation of adenosine phosphosulphate (APS) from adenosine monophosphate without the participation of oxygen (Suzuki 1974, Lyric and Suzuki 1970b):

$$AMP + SO_3^{2-} \rightarrow APS \qquad (2.27)$$
$$APS + HPO_3^{2-} \rightarrow ADP + SO_4^{2-} \qquad (2.28)$$

$$2ADP \rightarrow ATP + AMP \qquad (2.29)$$

The differences between the pathways for energy production explain the observed variations in carbon dioxide fixation efficiency between T. denitrificans and other thiobacilli.

The oxidation of soluble oxy-sulphur compounds such as thiosulphate ($S_2O_3^{2-}$) requires a thiosulphate-cleaving enzyme. Most thiobacilli use rhodanase to yield elemental sulphur and sulphite (Charles and Suzuki 1966, Suzuki 1974):

$$S\text{-}SO_3^{2-} \rightarrow S^\circ + SO_3^{2-} \qquad (2.30)$$

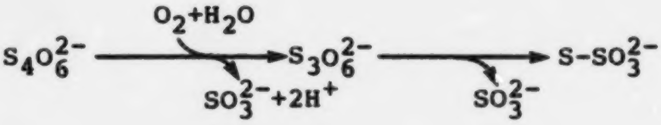
The cyanide degrading thiobacilli can couple the reaction with cyanide to yield thiocyanate (SCN) as the initial reaction:

$$S\text{-}SO_3^{2-} + CN^- \rightarrow SO_3^{2-} + SCN^- \qquad (2.31)$$

A different thiosulphate pathway involves thiosulphate oxidation to yield tetrathionate ($S_4O_6^{2-}$) by the following reaction:

$$2S\text{-}2SO_3^{2-} \rightarrow {}^-O_3S\text{-}S\text{-}S\text{-}SO_3^- \qquad (2.32)$$

Tetrathionate, in turn, is believed to be used by progressive enzymatic oxygenation and splitting to yield sulphite:



$$S_4O_6^{2-} \xrightarrow[SO_3^{2-}+2H^+]{O_2+H_2O} S_3O_6^{2-} \xrightarrow[SO_3^{2-}]{} S\text{-}SO_3^{2-} \qquad (2.33)$$

The oxidation process from sulphur to sulphate is electrochemical in nature involving six electron transfers (Fischer et al. 1965a and 1965b). Although thiobacilli can capture only a fraction of this energy, it supports the energy requirement for the fixation of carbon dioxide and biosynthesis.

2.3.3 Mechanism of Carbon Dioxide Fixation

Carbon dioxide is the sole source of carbon for autotrophically growing bacteria. The efficiency of carbon dioxide fixation is dependent on the biochemical energy yield from the inorganic energy source. Arkesteyn (1979) has reported, for example, that T. ferrooxidans at pH 3.0 requires 82 moles Fe^{2+}, 5 moles of FeS_2 and 6 moles of S°, respectively, to fix 1 mole of carbon dioxide. The primary mechanism of carbon dioxide fixation is the Calvin-Benson cycle shown on Figure 2.2 (Gale and Beck 1967, Din et al 1967, Silver 1978). In this metabolic pathway, the reaction between ribulose-1-5-bis-phosphate (RuBP) and carbon dioxide is catalyzed by RuBP carboxylase to form phosphoglyceric acid (PGA) as indicated below:

$$RuBP + CO_2 \rightarrow 2PGA \qquad (2.34)$$

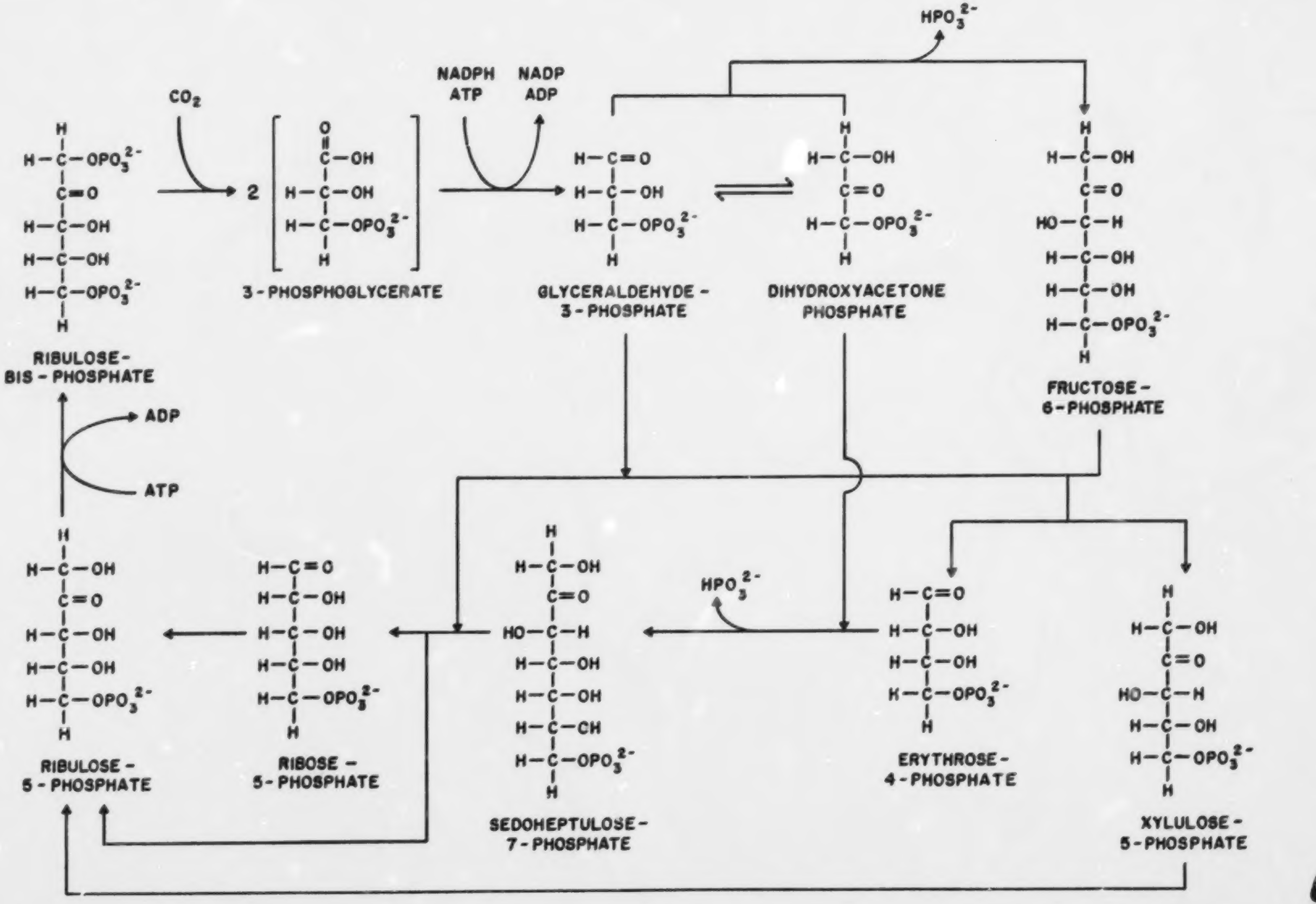
The incorporation of phosphoglyceric acid into biomass requires the coenzymes NADH or NADPH as the reducing agent. Carbon dioxide fixation by the Calvin-Benson cycle has been estimated to have an energy requirement of 3ATP equivalents per mole of carbon dioxide fixed.

In most aerobic bacteria, the Krebs cycle constitutes a central metabolic pathway. Obligate chemolithotrophic thiobacilli have been found to lack - ketoglutarate oxidoreductase, an important enzyme of this cycle (Andersen and Lundgren 1969, Matin 1978). To synthesize 4-carbon metabolites, these organisms must fix carbon dioxide via phosphoenol pyruvate (PEP) (Din et al 1967, Matin 1978)

$$PEP + CO_2 \rightarrow Oxalacetate + P_i \qquad (2.35)$$

FIGURE 2·2

THE CALVIN-BENSON CYCLE OF CARBON DIOXIDE FIXATION


CO$_2$
NADPH
ATP
NADP
ADP
HPO$_3^{2-}$
RIBULOSE-BIS-PHOSPHATE
3-PHOSPHOGLYCERATE
GLYCERALDEHYDE-3-PHOSPHATE
DIHYDROXYACETONE PHOSPHATE
FRUCTOSE-6-PHOSPHATE
ADP
ATP
RIBULOSE-5-PHOSPHATE
RIBOSE-5-PHOSPHATE
SEDOHEPTULOSE-7-PHOSPHATE
HPO$_3^{2-}$
ERYTHROSE-4-PHOSPHATE
XYLULOSE-5-PHOSPHATE

The facultative thiobacilli, *T. novellus* and *Thiobacillus A2*, possess pyruvate carboxylase activity in addition to PEP (Charles et al 1984). The reaction occurs in two stages as summarized below:

$$\text{Enzyme-Biotin} + HCO_3 + ATP \overbrace{\rightarrow}^{K^+, Mg^{2+}} \text{Enzyme-Biotin} - CO_2 + ADP + P_i$$

$$\text{Enzyme-Biotin} - CO_2 + \text{pyruvate} \rightarrow \text{Enzyme-Biotin} + \text{Oxalacetate} \qquad (2.36)$$

Pyruvate carboxylase activity is rare in thiobacilli. Most species, particularly the acidophilic thiobacilli, are unable to carboxylate pyruvate to form 4-carbon compounds (Matin 1978).

3.0 PYRITE OXIDATION KINETICS

3.1 Identification of Kinetic Relationships

3.1.1 Bacterial versus Chemical Oxidation

Pyrite oxidation by natural weathering is enhanced in the presence of oxygenated water, the rate depending on numerous factors. Oxygen (O_2) and ferric iron (Fe^{3+}) are recognized to be the principal oxidants in the reaction. Accordingly, the following stoichiometric equations have been cited throughout the literature:

$$FeS_2(s) + 7/2O_2 + H_2O \rightarrow Fe^{2+} + 2SO_4^{2-} + 2H^+ \qquad (3.1)$$
$$Fe^{2+} + 1/4O_2 + H^+ \rightarrow Fe^{3+} + 1/2H_2O \qquad (3.2)$$
$$FeS_2(s) + 14Fe^{3+} + 8H_2O \rightarrow 15Fe^{2+} + 2SO_4^{2-} + 16H^+ \qquad (3.3)$$

For kinetic purposes, equation (3.1) can be considered to represent the overall reaction stoichiometry. Equations (3.2) and (3.3) reflect mechanistic sequences, equation (3.2) being mediated by bacteria while equation (3.3) is non-biological. Equation (3.1) is the stoichiometric combination of the latter two.

The rate of chemical oxidation of ferrous iron to the ferric state (equation (3.2)), is strongly pH dependent above pH 4.5 whereas, below pH 3.5 the reaction rate is essentially pH independent. Whatever the pH regime, oxidation of ferrous iron by chemical means is a slow reaction (Singer and Stumm 1970, Lowson 1982) and has been suggested as the rate-limiting reaction. In natural acidic systems however, the reaction rate is greatly accelerated by microbial activity. Microbiolocally mediated pyrite oxidation has been reported to exceed the chemical oxidation rate by a factor of up to 10^6 (Singer and

Stumm 1970). Much less significant increases in the reaction rate have also been reported. The individual findings are undoubtedly a reflection of the particular conditions of the experiments. While the actual factor may be in question, there is little doubt that the iron and sulphur oxidizing bacteria significantly accelerate the oxidation of pyritic material.

3.1.2 Rate Equations

The mechanisms and kinetics of bacterial assisted pyrite oxidation processes have been reviewed and assessed on numerous occasions (MacDonald and Clark 1970, Dugan and Randles 1971, Wong et al 1974, Guay et al 1977, Torma and Sakaguchi 1978, Gleason et al 1978, Hoffmann et al 1981, Brown and Forshaug 1983, Jaynes et al 1984a).

In a heterogeneous system, pyrite oxidation is often expressed as a flux (rate of oxidation per unit surface area) in the following manner:

$$R_1 = -\frac{1}{A}\frac{dN_p}{dt} \qquad (3.4)$$

where

N_p = amount of pyrite present

A = surface area of the pyritic material

t = time

R_1 = pyrite oxidation flux

When the surface area of the pyritic material is unknown, the reaction rate is determined on a unit mass basis as follows:

$$R_2 = - \frac{1}{W} \frac{dN_p}{dt} \qquad (3.5)$$

where:

W = mass of pyritic material

R_2 = rate of reaction (unit mass basis)

The term, dN_p/dt in equations (3.4) and (3.5) is a complex function of bacterial concentration, pyrite reactivity, oxygen concentration, and environmental variables such as the temperature, moisture content, and the pH.

Taking the overall stoichiometry of equation (3.1) into consideration, the reaction rate expression given in equations (3.4) or (3.5) can be rewritten in terms of the disappearance of oxygen or the formation of ferrous iron or sulphate. Equation (3.4), for example, thus becomes:

$$R_1 = - \frac{1}{A} \frac{dN_p}{dt} = - \frac{1}{3.5A} \frac{dN_{OXY}}{dt} \quad \frac{1}{A} \frac{dN_{IRON}}{dt} = \frac{1}{2A} \frac{dN_{SULF}}{dt} \qquad (3.6)$$

Alternatively, if the reactor volume remains constant the rate of reaction can be expressed in terms of concentration. Whatever the choice of expression, it is apparent that the surface area and amount of material have a direct bearing on the overall rate of reaction.

The rate of bacterial oxidation (dX/dt) is related to the rate of pyrite oxidation (dN_p/dt) by a growth yield coefficient ($Y_{x/s}$) as follows:

$$Y_{x/s} \frac{dN_p}{dt} = \frac{dX}{dt} \qquad (3.7)$$

From data provided by Myerson (1981) the growth yield coefficient for pyrite oxidation is 2.2×10^{-2} to 2.6×10^{-2} g bacterial protein per g pyrite oxidized. The specific growth rate can be derived by normalizing equation (3.7) with regard to bacterial population density. The specific growth rate of T. ferrooxidans usually has been expressed by the Monod equation:

$$Y_{x/s} \quad \frac{1}{X}\,\frac{dN_p}{dt} = \frac{1}{X}\,\frac{dX}{dt} = \nu_{max}\,\frac{S}{K_m + S} \qquad (3.8)$$

which in its more familiar form becomes:

$$\nu = \frac{\nu_{max}\,S}{K_m + S} \qquad (3.9)$$

where

ν = the specific growth rate ($time^{-1}$)
ν_{max} = maximum growth rate ($time^{-1}$)
K_m = the half-saturation constant (mass)
S = the substrate concentration (mass)

Equation (3.9) can be linearized by rearranging the expression to form the Lineweaver-Burk equation:

$$\frac{1}{\nu} = \frac{K_m}{\nu_{max}}\,\frac{1}{S} + \frac{1}{\nu_{max}} \qquad (3.10)$$

The linearized form is most often used in evaluating kinetic constants (Gale and Beck 1967, Silver and Lundgren 1968, Schnaitman et al 1969, MacDonald and Clark 1970, Wong et al 1974, Tomizuka et al 1976, Eccleston and Kelly 1978, Kelly and Jones 1978, Torma and Sakaguchi 1978, DiSpirito and Tuovinen 1982b, Brown and Forshaug 1983). However, as observed by Wong et al (1974) the linear transformation of a nonlinear model is not the most appropriate technique for discriminating between models or estimating parameter values. Rather, they found that a Bayesian technique gave better results and permitted identification of a non-competitive inhibition mechanism which was otherwise not obvious from the raw data. Nonetheless a Monod type mechanism (such as Equation 3.8) was found to be valid for microbial oxidation of pyritic material. Brown and Forshaug (1983) also applied statistical techniques in analyzing laboratory-scale data and found that both a modified Monod relationship and an empirical model adequately described the microbial growth kinetics.

In summary, techniques for evaluating bacterial growth rates and substrate oxidation kinetics are well developed. Nonetheless, these models are recognized as being very simplistic descriptions of complex processes. Many factors are known to influence the bacterial kinetics of pyrite oxidation including reactivity of the pyritic material, surface area of the exposed material, the quantity of pyrite, the pH and temperature, disolved oxygen and carbon dioxide levels, presence or absence of toxicants or inhibitors, availability of micro-nutrients, etc. An evaluation of the significance of these and other factors is presented in the following sections.

3.2 Identification of Rate Controlling Factors

3.2.1 Background

The oxidation of pyritic material is recognized to be a complex process which is affected by several physical, chemical and biological factors. As noted by Nordstrom (1982) "several types of oxidation-reduction reactions, hydrolysis and complex ion formation, solubility controls and kinetic effects" are involved. Many of these have been investigated and reported in the open literature.

A summary of the pertinent literature is presented in this section on those factors which affect the rate of bacterially assisted pyrite oxidation. In those instances where the level of current understanding is shown to be incomplete or in doubt, recommendations are made, as appropriate, for future research work.

3.2.2 Reactivity of Pyritic Material

The extent of acid production is influenced by the reactivity of pyritic material. In coal, sulphur exists as organic, sulphate, or pyritic sulphur (Caruccio et al 1981). The organic sulphur content of coals reportedly occurs consistently between 0.35 to 0.5 percent (w/w basis) but is generally not chemically reactive. Sulphate sulphur which represents the oxidation product of the metal sulphides, has not been found in measurable amounts and therefore does not contribute significantly to acid production. The main contributor to acid mine drainage has been found to be the pyritic sulphur component.

Pyrite and marcasite are the most abundant forms of iron disulphide. The sulphur to iron atomic ratios for these two forms are the same yet their crystallographic properties are different. Marcasite has a orthorhombic structure while pyrite is cubic or isometric. Marcasite is less stable and oxidizes more readily than pyrite (Paciorek et al 1980). On the other hand, pyrite is more abundant, in North American coals at least, and is recognized as the major source of acid mine drainage (Apel 1982).

The pyritic material associated naturally with refuse or waste rock piles and mine tailings occur as noncrystalline grains which are dispersed heterogeneously throughout the host material. The most reactive pyritic material is commonly referred to as "framboidal" or "sulphur ball" pyrite (Caruccio et al 1980 and 1981, Lowson 1982). Framboidal pyrite has a grain size typically in the range of 0.05 to 1.0 μm (Lowson 1982). The grains may agglomerate to form a small mass resembling a strawberry or framboid with a typical diameter of 53 μm. The literature on framboidal pyrite has mainly been associated with coal deposits although it has been identified with other mineral formations.

While the reactivity of the pyritic material is regarded as an important factor in determining the acid generation potential of waste rock piles and tailings, it is not the sole contributing factor. Similarly, measurement of the sulphur and calcareous contents of the waste material, as the basis for estimating the acid generation potential and the buffering capacity respectively, has been shown to be inadequate in many cases. To more closely mimic actual environmental conditions, requires leaching experiments. Laboratory test procedures and acid generation potential calculation methodologies are reported in the literature (Duncan and Walden 1975, Caruccio et al 1980 and 1981, Caruccio and Geidel 1981).

Summary: The reactivity of the different forms of pyritic material is recognized to be an important factor in determining the acid production potential of ores and wastes. Means of measuring the reactivity directly, however, have not been developed. Consequently, leaching experiments are required to determine the acid generation potential of each pyritic material under optimized bacterial leaching conditions. Procedures for performing the leaching experiments have been well established from previous research on pyrite oxidation.

3.2.3 Quantity and Surface Area of Pyritic Materials

Both the quantity and surface area of sulphidic material have frequently been shown to be important factors in determining the rate of acid production. In early work carried out by Bryner and Anderson (1957), the rate of molybdenum dissolution from molybdenite ore separated into three particle size groupings (i.e. <250 μm, >250μm to <590 μm and >590 μm to <1000 μm) was studied using airlift percolators and an inoculum of autotrophic bacteria grown on a molybdenite concentrate and pyrite medium. They reported conclusive evidence that the rate of bacterial oxidation increases with decreasing particle size (i.e. increasing surface area of particles).

Razzell and Trussell (1963a) reported on bacterial leaching of copper ores using percolators similar to those used by Bryner and Anderson (1957). Essentially a linear increase in the leach solution copper concentration was observed for copper ore charges of 2,4,6,8 and 10g to the test reactors. The percent copper recovery from the five percolators, at the end of a 44 day test period was nearly equal, varying from 12 to 14 percent. It was also found that copper was released more rapidly from fine particles than from coarse particles. At the end of 33 days, about twice as much copper had been leached from particles of less than 44 μm size as compared to particles of less than 74 μm size and approximately eight times more copper had been leached from the 44 μm size particles than from particles with a diameter between 74 and 105 μm(Razzell and Trussell 1963a). Ehrlich and Fox (1967) found that reducing the particle size of a synthetic copper sulphide from the 125 to 177 μm range to less than 62μm resulted in a doubling of the bacterial oxidation (i.e. copper solubilization) rate.

Similar findings have been observed during bacterial leaching of zinc sulphide concentrate in shaker flask experiments (Torma et al 1970 and 1972). Operating at a leach solution pH of 2.3 and temperature of 35°C, the effect of varying the pulp density from

1 to 26.6 percent solid (w/v basis) was first investigated. A linear increase in the zinc leaching rate was observed up to a maximum of 360 $mg.L^{-1}.hr^{-1}$ for an optimum pulp density of about 120 $g.L^{-1}$ (12 percent solids) using normal air with a carbon dioxide content of 0.03 percent. Using enriched air containing from 0.23 to 7.92 percent carbon dioxide, the maximum zinc extraction rate equalled 640 $mg.L^{-1}.h^{-1}$ at an optimum pulp density of about 240 $g.L^{-1}$ (24 percent solids). The zinc extraction plots in all cases were found to increase linearly up to a maximum beyond which no further increase was observed. Very similar findings were noted in leaching experiments using several different particle size fractions of known specific surface areas, reported as $m^2.g^{-1}$. The surface area of the various size fractions were determined by the BET technique which is based on nitrogen adsorption using a dynamic nitrogen adsorption apparatus. When the zinc extraction rate data were plotted against surface area of the ore particles, expressed as surface area per unit volume of liquid medium, the effect of changing particle size versus changing solids concentration gave nearly identical results (Torma et al 1970).

Bacterial leaching experiments using Elliot Lake uranium ores have revealed identical results to those reported for the other metal sulphides. T. ferrooxidans isolated from the mine drainage at Elliot Lake were found to significantly increase the rate of dissolution of uranium from crushed ore samples as compared to the findings in parallel control reactor experiments using a bacterial inhibitor (Harrison et al 1966a and 1966b). In addition, the rate of dissolution was enhanced by increasing the surface area of the ore particles (i.e. grinding the ore samples to a smaller particle size distribution). Uranium leaching was quite slow for particle sizes greater than 4.75 mm with thirty-two weeks required to achieve 70 percent extraction. Even on particles of minus 4.75 mm diameter, twenty weeks were required to effect 90 percent uranium solubilization

Tests with pyritic material have produced similar results to those reported for other sulphide minerals. Paciorek et al (1980) conducted bacteria-free leaching tests using pyrite separated into a size fraction of less than 38 µm and another containing particles between 125 and 250 µm. Using equal amounts of these two particle size groupings, the reactor with the smaller sized fraction leached more readily as demonstrated by an increased rate of iron dissolution and a faster decline in the leach solution pH. Similar results were obtained in experiments using two different quantities of pyrite. The reactor with 10 $mg.L^{-1}$ pyrite had about twice as much iron in solution at the end of the 96 hour leach period as compared to the reactor with 5 $mg.L^{-1}$ pyrite. The pH of the former reactor also declined more quickly and reached a lower terminal value.

Cherry et al (1983) conducted a series of pyrite oxidation tests at neutral pH conditions using five different particle size groupings (i.e. 45 to <63 µm, >63 to <90 µm, >90 to <125 µm, >125 to <180 µm and >180 to <250 µm). The experiments were carried out in percolator apparatus using pure pyrite or pyrite concentrate mixed with silica sand in the ratio or 1 to 9 (w/w basis) respectively. A gas phase composition of 20 percent oxygen, 0.5 percent carbon dioxide and 79.5 percent nitrogen and a buffered feed water to maintain neutral pH were employed in these experiments. The results indicated that there was a linear relationship between the oxidation rate, measured as the rate of sulphate production in these experiments, and the surface area, which was inferred from the particle size groupings. Five different types of pyrite obtained from an equal number of worldwide locations were also tested by these researchers to determine whether or not the oxidation rate was dependent on the pyrite source. Both pure pyrite specimens and pyrite concentrate were tested. Quite similar oxidation rates were observed for all pyrite types.

Investigation of oxidation kinetics and parametric factors which influence the oxidation of representative pyritic coals was undertaken by Hoffmann et al (1981) at a constant temperature of 25°C under acid pH conditions using reactions flasks on reciprocating shakers. In one set of experiments, coal samples were ground and separated into two particle size grouping (i.e. <43 μm and >43 to <74 μm) and inoculated with *T. ferrooxidans*. Plots of the cumulative sulphate produced versus time showed that the rate of pyrite oxidation was highest for the smaller particle size fraction (i.e. largest surface area) for a fixed mass of coal.

The oxidation rate increased linearly with increasing surface area. When the particle size was held constant, increasing slurry concentrations resulted in a similar linear dependence of the reaction rate. In most studies involving pyrite oxidation, the surface area was calculated by assuming spherical particle geometry. Although this assumption tends to underestimate the true surface area (Lowson 1982), it offers a reasonable basis for comparing relative oxidation rates.

Summary: The rate of pyrite oxidation has been demonstrated to increase in direct proportion to the quantity of material being leached up to an optimum pulp density beyond which no further increase in the oxidation rate occurs, presumably due to some other limiting factor. A similar linear increase in the pyrite oxidation rate has been observed by increasing the surface area of the pyritic material. Direct measurement of the surface area of the finely grained particles has been less frequently attempted; rather it has generally been inferred from an analysis of particle size distribution. Consequently, the relationship between oxidation rate and particle size surface area has not been well established. For the results of leaching experiments to be comparable, knowledge of the particle size distribution, as a minimum, or preferably measurement of the surface area of the pyritic specimens is required.

3.2.4 Direct Versus Indirect Bacterial Contact

There has been extensive discussion and conjecture in the literature about the mechanism of microbial pyrite oxidation. The discussion centers around whether the pyrite is subject to direct bacterial attack with oxidation occurring via enzymatic pathways, indirectly by bacterial oxidation of dissolved ferrous iron to ferric iron which in turn oxidizes the pyrite and is again reduced to ferrous iron or, by a combination of these two mechanisms.

Circumstantial evidence supporting the direct contact mechanisms is found throughout the literature. For example, Bryner and Anderson (1957) found in laboratory experiments in which the liquid phase was drained weekly from the test apparatus that it was not necessary to reinoculate the reactors as ample bacterial growth was retained on the solid particles. Bacterial growth on the solid phase was confirmed by microscopic examination of the particles.

Similar findings were reported by McGoran et al (1969) on a series of laboratory experiments in which the distribution of *T. ferrooxidans*, between the solid phase and liquid phase was measured on three different growth substrates, ferrous iron, sulphur and chalcopyrite. The bacterial distributions were measured in these experiments by direct cell counts, optical density measurements and nitrogen determinations. Bacterial association with the solid phase was high in all cases with greater than 95 percent attachment for bacteria grown on the ferrous iron and the chalcopyrite substrates and approximately 75 percent attachment for the bacteria grown on the sulphur substrate.

Measurement of the bacterial distribution between the liquid and solid phases in a pilot scale reactor was also attempted using several different techniques including bacterial counting and protein analysis (Le Roux et al 1973). The authors reported that there was approximately six times more bacteria associated with the solid phase than with the liquid phase. Furthermore, it was found that the bacteria could not be dislodged from the solid particles even on vigorous agitation. A similar finding has been reported by Myerson and Kline (1983) in controlled laboratory experiments designed to measure the kinetics of bacterial adsorption onto coal particles. These authors reported that bacteria adsorped rapidly and were irreversibly attached to the coal particles.

The ability of T. ferrooxidans to adhere to the surface of particles has been attributed to the excretion of pili by several strains (DiSpirito et al 1982). The sorption of T. ferrooxidans onto five different types of fine grained solid media has also been reported (DiSpirito et al 1983). Bacterial sorption,as measured by analysis of protein content, occurred rapidly and reached steady state conditions within one hour on quartz, pyrite, glass beads and fluorapatite particles. Due to the poor wetting characteristic of flowers of sulphur, the rate of sorption was found to be slower than with the other particulates, although preincubation of the elemental sulphur for 24 hours resulted in a comparable initial sorption rate. The effect of increasing the concentrations of the particulate materials resulted in higher cell removal although not in direct proportion to the particlulate concentration. Varying the solution pH from

1 to 4 had no influence on bacterial sorption onto any of the particulate materials tested with the exception of the glass beads. On the glass beads the mass of bacteria attached to the beads declined with increasing pH. An explanation for this observation was not offered.

Additional evidence in support of the direct-action theory is provided by the work of Beck and Brown (1968). Using four substrates, ferrous iron, elemental sulphur, pyrite and chalcopyrite, these investigators monitored oxygen and carbon dioxide utilization efficiencies by two cell suspensions of *T. ferrooxidans*. The efficiencies of oxygen and carbon dioxide fixation in both pyrite and chalcopyrite oxidation were found to fall between those measured for ferrous iron and sulphur oxidation alone, suggesting that, both components of the sulphide ores were attacked by the bacteria.

Investigation of the ability of *F. ferrooxidans* to oxidize reduced iron and elemental sulphur was undertaken using conventional manometric procedures by Margalith et al (1966). Cultures of the bacteria grown on ferrous sulphate media and on elemental sulphur were used in the experiments. Comparable oxygen uptake rates were recorded for ferrous iron oxidation by the iron-grown and sulphur-grown cells. In contrast, the sulphur-grown cells oxidized elemental sulhur about twice as fast as the iron-grown cells. On mixed iron-sulphur substrate, the oxygen uptake curves measured for both cell cultures suggested that ferrous iron was oxidized first followed by sulphur oxidation. Again the sulphur-grown cells oxidized the sulphur component at a higher rate. These investigators did not observe a lag in the time to start of sulphur oxidation which some researchers had previously reported. Margalith et al (1966) concluded from their work that the iron oxidation system of *F. ferrooxidans* is of a constitutive nature. The fact that ferrous iron oxidation preceded sulphur oxidation was believed to be due to higher solubility of iron which allows it to reach the active oxidizing sites more readily. It was also postulated that the increased activity of the sulphur oxidizing system of sulphur-grown cells may be due to a change in the relative numbers of bacteria of different strains, assuming the original culture was heterogenous.

Le Roux et al (1973) carried out parallel shaker flask experiments in which the rates of pyrite oxidation by a ferric salt in sterile reactors and by bacteria plus the ferric salt in inoculated reactors were monitored simultaneously. In the sterile reactors, only 2 to 3 percent of the pyrite was oxidized before the reactions essentially ceased. This observation was attributed, at least in part, to the buildup of a sulphur coating on the pyrite particles. Washing of the particles from the sterile reactors with organic solvents was found to restore reactivity and allow a further 2 to 3 percent of the pyrite to oxidize on addition of ferric salt. In the bacterially inoculated reactors however, the reactions proceeded to completion with greater than 99 percent pyrite oxidation. The ferrous iron concentration was found to peak around the third week and decrease to a low residual value at the end of the twelve week test period. There apparently was no buildup of sulphur on the pyrite. The authors thus concluded that T. ferrooxidans assisted in the oxidation of both the ferrous iron and sulphur moieties.

Conclusive evidence of the direct oxidation of the sulphur moiety of pyrite by T. ferrooxidans has been presented by Arkesteyn (1979). In one set of experiments, Arkesteyn examined the effect of separating the pyrite from the bacteria by means of a dialysis bag. The effect was observed to be a pronounced drop in the oxidation rate as compared to the rate measured when the bacteria were in direct contact with the substrate. In addition, the oxidation rate measured in the dialysis bag experiment was similar to the rate observed when N-ethylmaleimide (NEM), a known inhibitor of sulphur oxidation, was added to bacterial suspensions growing in direct contact with pyrite. Other observations which were reported to support the theory of direct enzymatic oxidation of the sulphur moiety of pyritic material included: the presence of b-type cytochrome in bacterial cells grown on pyrite and elemental sulphur but not in cells grown on ferrous iron; a reduction in the b-type cytochrome level in whole cells when pyrite or elemental sulphur was added; continuous bacterial oxidation of elemental sulphur and pyrite over the pH range from 2.8 to 7.0 but negligible bacterial ferrous iron oxidation at pH 5.0 or above; and, a carbon dioxide fixation rate per mole of oxygen consumed for cells grown on pyrite which was intermediate to the rates measured for cells grown on ferrous iron and elemental sulphur alone.

The role of T. ferrooxidans in oxidizing ferrous iron to ferric iron is well established; ferrous sulphate is the main ingredient of the standard 9K culture medium (Silverman and Lundgren 1959a). The role of ferric iron in chemically oxidizing pyrite and other metal sulphides has similarly been shown conclusively (Dutrizac and MacDonald 1974, Singer and Stumm 1970). The cyclic pattern of bacterial oxidation of ferrous iron to ferric iron and the reduction of the ferric iron in the oxidation of additional pyrite (ie. the indirect contact mechanism) has proven to be more difficult to demonstrate.

In a series of manometric experiments, Silverman (1967) found that pretreatment of pyrite with acid apparently removed the soluble iron and depressed the subsequent rate of bacterial oxidation which resulted in a nonlinear oxygen consumption curve. Treatment of the acid leached pyrite with ferric sulphate however, was found to restore approximately two-thirds of the bacterial oxidation kinetics with the oxygen utilization curve returning to a linear form. Ferric iron was also observed to oxidize pyrite in the absence of bacteria and oxygen according to the reaction:

$$FeS_2 + Fe_2(SO_4)_3 \rightarrow 3FeSO_4 + 2S° \qquad (3.11)$$

Silverman inferred from this work that both the direct and indirect contact mechanisms were active in pyrite oxidation.

The investigations of Arkesteyn (1979) discussed previously not only demonstrated that the sulphur moiety is oxidized by direct contact but also showed that the pyrite is oxidized indirectly via bacterial oxidation of the dissolved ferrous iron to ferric iron which serves as the oxidant in the dissolution of pyrite. In the experiment with the dialysis bag, pyrite oxidation proceeded but at a rate below that measured with direct bacterial contact. Oxidation stopped at a pH of 5.0 as found in the reactors when the bacteria were in direct contact with the pyrite. The addition of the sulphur oxidizing inhibitor NEM to the dialysis bag had no effect on the pyrite oxidation rate which suggested that only the iron moiety was being bacterially oxidized. Presumably this occurred by diffusion through the dialysis bag of ferrous iron released from the pyrite.

Tomizuka and Yagisawa (1978) also conducted dialysis bag type experiments to determine whether direct bacterial contact was necessary for leaching of uranium ore. In their experimental setup, a ferrous sulphate medium was placed inside a cellulous membrane and a inoculum of T. ferrooxidans was added to the medium. The uranium ore occupied the chamber space outside the dialysis bag. Uranium solubilization was observed to proceed following inoculation of the iron medium and adjustment of the solution pH to promote bacterial growth. The data showed that uranium leaching occurred via the indirect contact mechanism with ferric iron presumably acting as the primary oxidant. In another set of experiments in which the rate of galena (PbS) oxidation was monitored it was demonstrated that ferrous iron added to inoculated samples hastened the rate in contrast to reactors which contained essentially no iron. The role of bacteria in oxidation of galena was attributed to being one of oxidizing the sulphur moiety. The function of iron was speculated to be one of enhancing the activity of the bacterial oxidizing systems and/or increasing the rate of chemical oxidation of the galena.

Summary: The evidence presented in the literature strongly suggests that bacteria catalyze the oxidation of the metal sulphides via both the direct and indirect contact mechanisms. There is little doubt that the bacterial oxidation of soluble ferrous iron to ferric iron plays a major role in the subsequent chemical oxidation of sulphidic material. Bacteria thus play a pivotal role in the cyclic oxidation process involving the iron moiety. The implication of bacteria in oxidizing the sulphur moiety has proven to be more difficult to conclusively verify. Confirmatory data are required to substantiate the role and mechanisms of bacteria in pyrite oxidation.

3.2.5 Oxygen Availability

Oxygen is often considered to be the limiting reactant in the bacterial oxidation of pyrite and metal sulphide minerals, whether it be in low grade ore leaching operations or in mining industry waste piles. Means of improving the oxygen supply have been investigated in leaching operations by several investigators. Conversely, means of limiting the oxygen supply to minimize acid production in mines and mine waste piles have been studied by numerous researchers.

Oxygen utilization has historically been measured as a indicator of bacterial activity in controlled experiments. Measurement of oxygen uptake was reported by Silverman and Lundgren (1959b) in their early manometric studies. In repeated experiments using five different harvests of F. ferrooxidans, these investigators found that the oxygen uptake was consistent with the theoretical amount given by the equation:

$$4FeSO_4 + O_2 + H_2SO_4 \rightarrow 2Fe_2(SO_4)_3 + 2H_2O \qquad (3.12)$$

Oxygen utilization ranged from 92.7 to 101.8 percent of the theoretical requirem [illegible] n experiments using substrate additions from 50 to 500 μmoles of ferrous iron. Beck (1960) reported very similar findings on an independent set of manometric experiments in which ferrous iron substrate additions of 50 to 100 μmoles were investigated.

Over twenty years later DiSpirito and Tuovinen (1982a) reported comparable findings from manometric studies of both ferrous iron and uranous ion oxidation by T. ferrooxidans grown on ferrous sulphate media at pH 1.5. Oxygen uptake coupled with ferrous iron oxidation equalled about 92.5 percent of the theoretical value given by the equation above for ferrous iron additions of 0, 40, 100, 200, and 300 μmoles in a total volume of 4 ml. Uranous ion oxidation was measured for additions of 0, 10, 20, 40 and 60 μmoles in a total volume of 4 ml. Oxygen utilization in these experiments equalled approximately 107 percent of the stoichiometric requirement give by:

$$2UO_2 + O_2 + 2H_2SO_4 \rightarrow 2UO_2SO_4 + 2H_2O \qquad (3.13)$$

Chemical oxidation was negligible in both sets of experiments. The authors concluded therefore, that T. ferrooxidans possessed the ability to oxidize reduced uranium, as well as reduced iron, and derive metabolic energy in the process. Ivarson (1980) drew similar conclusions from manometric experiments which showed the bacteria accelerate the rate of oxygen uptake associated with uranous ion oxidation.

Nielsen and Beck (1972) demonstrated that a T. ferrooxidans culture derived from a copper mine water environment increased the rate of chalcocite (Cu_2S) oxidation in manometric experiments. The ratio of oxygen consumed to microbially dissolved copper formed was measured to equal 0.43. This ratio was reported to coincide with the findings of previous investigations in which a range of 0.42 to 0.51 was determined in the oxygen consumed to copper dissolved ratio. The results of these investigations closely agree with the postulated expression for chalcocite oxidation:

$$2Cu_2S + 2H_2SO_4 + O_2 \rightarrow 2CuS + 2CuSO_4 + 2H_2O \qquad (3.14)$$

Mineralogical analysis of the oxidized substrate demonstrated the presence of large quantities of digenite (Cu_9S_5) and covellite (CuS) (Nielsen and Beck 1972). Similar observations were reported by Silver and Torma (1974) from x-ray diffraction examination of the solid phase products of chalcocite microbial oxidation. The mineral residue in this study was found to contain digenite (Cu_9S_5), antlerite ($Cu_3SO_4(OH)_4$), covellite (CuS) and metallic copper.

Because the growth of aerobic bacteria is influenced by oxygen availability, there has been considerable interest, although limited research, into determining the critical oxygen concentration below which oxygen acts as the limiting substrate thus limiting the bacterial growth rate. An important contribution in this area of research has been made by Myerson

(1981) who undertook several laboratory scale, stirred reactor experiments using pyrite substrate. Critical oxygen concentrations in bulk solution for the growth of T. ferrooxidans at a pH of 2.5 were determined for several temperatures as follows:

Temperature (°C)	Critical Oxygen Conc (m mol.L^{-1})
25	1.29×10^{-2}
28	1.22×10^{-2}
31	1.15×10^{-2}
34	1.09×10^{-2}

As the data indicate the critical oxygen concentration was found to be quite low, equalling approximately 5 percent (0.5 mg.L^{-1}) of the oxygen concentration at saturation.

Baker and Wilshire (1970a and 1970b) have reported on the roles of oxygen and chemoautotrophic microorganisms in the oxidation of pyritic material. Coarse ground material (i.e. 2.8 to 5.6 mm diameter) containing 95 to 98 percent pyrite was placed in four identical cylinders which were operated as continuous flow flooded-bed reactors for a period of up to 114 days. Two reactors were aerated continuously throughout the investigation while the other two reactors were not aerated for the first 80 days. These later reactors were aerated for the last 34 days to assess the effects of oxygen addition. One reactor from each set was seeded with chemoautotrophs at the start of the experiment. The results demonstrated that pyrite dissolution occurred at a similar rate in both anoxic reactors although at a much slower rate than in either aerobic reactor. Acid production in the anoxic reactors could be attributed entirely to the reduction of ferric to ferrous iron. There was no measurable sulphate in the effluent from the anoxic reactors during the initial 80 days of operation. Sulphate was produced however, in both aerobic reactors. The seeded reactor displayed a greater production rate initially although essentially equal rates were observed once the native bacterial population became established in the nonseeded aerated reactor. The release of sulphur as sulphate from the aerobic reactors was found to approximate the stoichiometric ratio expected from pyrite dissolution based on the iron and acidity data. Sulphate was also measured in the effluent of the anoxic reactors following conversion to the aerobic mode of operation. Acid production was much greater in the aerated reactors indicating the importance of oxygen and the chemoautotrophs in the oxidation of pyritic material. Pyrite dissolution was observed to occur under nonaerobic conditions, albeit at a much slower rate.

The potential effects of limiting the oxygen level in the coal mine atmosphere were studied in a series of laboratory scale columns (Robins and Troy 1971). The results showed that acid production as measured in terms of iron, sulphate, acidity or conductivity was proportional to the oxygen partial pressures in contact with the pyritic material. Nitrogen and methane were superior blanketing gases in reducing acid production to less than 1 percent of that measured in columns operating under a normal atmospheric environment. Carbon dioxide was also effective in reducing pyrite oxidation although slightly less effective than the other two gases. Acid production in columns operated under an inert gas atmosphere was affected by oxygen in the feed water. No difference in acid production was measured between supplying oxygen in the gaseous phase versus applying oxygen in the aqueous phase. Pyrite oxidation proceeded at an equal rate in both instances.

The proliferation of bacteria at low dissolved oxygen levels has been suggested by the work of Australian researchers investigating conditions in waste rock piles at the site of the Rum Jungle uranium mine (Daniel et al 1981a, Harries and Ritchie 1983). Monitoring of gaseous oxygen and carbon dioxide content in two separate waste rock dumps revealed that the oxygen content was less than 1 percent within 0.5 to 1.5 m of the surface in some areas while the carbon dioxide content was frequently in the range of 1 to 3 percent. T. ferrooxidans were found to be present in approximately equal numbers to a depth of greater than 3 m. The concentration of dissolved iron was generally highest near the surface whereas the soluble copper concentration increased with depth. These data were interpreted to indicate that the pyritic waste was being actively oxidized throughout at least the top 4 to 5 m of the pile. Temperature data collected on these dumps suggest that pyrite oxidation was occurring at even greater depths (Harries and Ritchie 1981, Daniel et al 1981b).

To assess the potential significance of pyrite oxidation under anaerobic conditions, Goodman et al (1983) carried out controlled laboratory tests using a nitrogen gas feed supplemented with 5 percent carbon dioxide. The tests were performed in an instrumented 1 L reactor vessel using a zinc-iron sulphide ore, ground to pass a 200 mesh sieve, (i.e. less than 74 μm particle size) and a T. ferrooxidans strain grown on a zinc sulphide media. The results indicated active oxidation of the ore substrate as compared to a sterile control, although the rate was quite slow. A seven fold increase in the nitrogen-carbon dioxide gas flow rate at day 94 resulted in an increase in the oxidation rate. After 140 days when the experiment was stopped, approximately 63 percent of the zinc and 86 percent of the iron had been dissolved. The pH of the leach solution remained stable at 2.5 throughout. In contrast, 100 percent of the zinc was solubilized from an ore sample within 20 days in a separate test carried out under aerobic conditions. Only 48 percent of iron was in solution at the end of the test although a portion of the iron may have been precipitated from solution as alkalinity reportedly was added to the reactor to maintain the pH at 2.5. The authors concluded from this work that:

i) T. ferrooxidans can leach a zinc-iron sulphide substrate in the absence of oxygen; and,

ii) the rate of oxidation increases as the carbon dioxide level is raised by increasing the gas flow rate.

Clearly, the findings of these investigators would have significant consequence to those involved with the development of close out strategies, if correct. However, the findings require that carbon dioxide act as the electron acceptor which from thermodynamic considerations does not seem plausible. The authors (Goodman et al 1983) have drawn analogy to methanogenesis from carbon dioxide, ie.:

$$H_2CO_3 + 4H_2 \rightarrow CH_4 + 3H_2O \qquad (3.15)$$

Indeed, the above reaction is thermodynamically favourable having a standard free energy ($\Delta G°$) of -139.1 KJ.mol^{-1}. In the case of zinc sulphide, as the reductant, the analogous reaction would be as follows:

$$ZnS + H_2CO_3 + H_2O \rightarrow Zn^{2+} + SO_4^{2-} + CH_4 \qquad (3.16)$$

The standard free energy of this reaction ($\Delta G° = +116$ KJ/mol), however, is highly unfavourable. In addition, the authors reported substantial concentrations of ferric ion under anaerobic conditions. Ferric ion is thermodynamically unstable in the absence of oxygen (Lundgren and Dean 1979). These considerations cast some serious doubts concerning the authors' conclusion. Unless a thermodynamically and mechanistically consistent model, supported by experimentally verified results is obtained, electron transfer based on carbon dioxide as the terminal acceptor cannot be substantiated.

The concept of limiting oxygen access to pyritic material in order to minimize pyrite oxidation, acid production and metal dissolution is one which has been advocated by numerous investigators. Flooding of worked out coal mines has been successful in the control of acid mine drainage in several instances with acidity reductions of 45 to 99 percent being reported (Gleason et al 1978). Air sealing which has also been attempted as a means of eliminating acid mine drainage from coal mines however, has proven to be much less successful as it is nearly impossible to prevent mine breathing (Brant and Shumate 1971, Gleason et al 1978).

As either mine flooding or air sealing is meant to minimize oxygen transport to the pyritic material, theoretically mine flooding should be more successful. Oxygen transport is directly proportional to oxygen diffusivity which is approximately 10,000 times greater through air than water for a given concentration gradient based on oxygen diffusivities of 2.06×10^{-1} $cm^2 * sec^{-1}$ through air and 1.8×10^{-5} $cm^2 * sec^{-1}$ through water at 25°C (Shumate and Brant 1971). Because oxygen is only slightly soluble in water, it is a much greater barrier to the diffusive transport of oxygen by a factor exceeding 10,000 as compared to air.

An example of the potential benefits to be derived from flooding underground mine workings has been recently reported for several anthracite coal mines in eastern Pennsylvania (Ladwig et al 1984). Field investigations at the mines, which were allowed to flood some 10 to 15 years ago, revealed that the mine waters which were formerly highly acidic were now slightly akaline. Sulphate reductions of approximately 54 and 74 percent in mine waters were seen in comparison to 1960's data. In addition, marked decreases in the iron, aluminum, manganese, calcium and magnesium levels were observed. Interestingly, monitoring in deep shafts indicated marked vertical stratification in five of the nine shafts investigated. Sharp changes in Eh, pH and other water quality parameters were observed with the more contaminated water occupying the lower levels. Water exchange and flushing was presumably minimal in the lower levels of these workings. The overall marked improvement in water quality in the inundulated mines was attributed by these authors to the probable inhibition of pyrite oxidation due to flooding, dissolution of carbonate minerals to buffer residual acidity and flushing of residual contaminants from the system.

The concept of flooding pyritic mine tailings to minimize acid production and metal or radionuclide leaching has beem evaluated although seldom applied (B.C. Research 1970, 1974 and 1980, Hawley 1975, Nanisivik Mines 1981, Halbert et al 1982). An extensive search of the literature on this specific topic identified some twenty-five tailings disposal schemes involving discharge directly under a water cover (SENES and Golder 1981). Of these operations, only six examples of disposal into freshwater environments were found.

An interesting example of underwater disposal is provided by the study of Mandy Lake, Manitoba by Hamilton and Frazer (1978). This study dealt with the ecological impact of copper tailings deposited some 35 years ago in a shallow lake. The pyritic tailings had a high sulphide content (15 to 17 percent sulphur) and appreciable amounts of zinc (1.7 percent) and copper (0.9 percent). Submerged tailings under a water cover of 0.2 to 1.1 m showed little evidence of oxidation or acidification. Typically, submerged tailings porewater pH values were around 6.9 in comparison to a surface water pH of 7.7 above the tailings. Only in partially exposed tailings deposited along the shoreline had the pH declined to 4.5. The authors reported vigorous revegetation and a healthy benthic community on the underwater tailings deposit.

In contrast, nearby exposed dry tailings of similar composition were found by these same investigators to have undergone substantial oxidation. A significant fraction of the sulphide minerals in the top 15 cm has been oxidized to iron oxides, sulphate and dissolved heavy metals. Soluble copper and zinc concentrations measured 797 $mg.L^{-1}$ and 218 $mg.L^{-1}$, respectively, and the pH value was approximately 2.5. The entire surface of the tailings remained void of vegetation (Hamilton and Frazer 1978).

Summary: It is widely accepted that oxygen is essential for the oxidation of pyrite by the autotrophic, chemolithotrophic bacteria to proceed. The research presented in the literature suggests that bacterial oxidation can proceed at quite low oxygen concentrations. Field data on leaching within waste piles support this contention while data on flooded coal mines and sulphidic tailings are less conclusive. Further research is required to determine the effects of limiting the oxygen supply on the kinetics of bacterial oxidation.

3.2.6 Carbon Dioxide Requirement

The growth of the autotrophic thiobacilli is dependent on the availability of carbon dioxide as the main carbon source. The importance of carbon dioxide as a limiting nutrient is dependent on the chemical nature of the waste material. For example, investigations at a pyritic waste rock dump in Australia revealed an active population of *T. ferrooxidans* at depths of at least 3 m, an oxygen content in the pore space gas phase of less than 0.1 percent by volume at depths below 0.5 m and a carbon dioxide content in the gas phase of 1 to 3 percent by volume within the dump (Daniel et al 1981a, Harries and Ritchie 1983, Goodman et al 1983). The high carbon dioxide content observed in these piles which were undergoing active bacterial oxidation, was attributed by the authors to the probable dissolution of dolomite known to be present in the waste material. In similar instances, carbon dioxide availability is unlikely to place a limitation on pyrite oxidation. In the case of uranium tailings which have undergone an acid leach in the mill however, the only significant source of carbon dioxide is likely to be that available in the air mass diffusing into the tailings pore space unless limestone has been purposely added to the tailings to control acidification.

Carbon dioxide has been measured as an indicator of bacterial activity dating back to the days of the early investigations. In manometric studies of the chemoautotrophic iron oxidizing bacterium, Silverman and Lundgren (1959b) measured carbon dioxide assimilation of about 1 μmoles oxygen in the oxidation of 50 umoles of ferrous iron. About the same time, Beck (1960) reported the results of manometric investigations using a T. ferrooxidans culture isolated from acid leach waters in Utah. The efficiency of carbon dioxide fixation during cell growth was measured to equal about 1 umole of carbon dioxide for each 100 umoles of ferrous iron oxidized, or approximately one-half the efficiency reported by Silverman and Lundgren (1959b).

The uptake of radioactive carbon by F. ferrooxidans growing on ferrous sulphate media was measured by Din et al (1967). They demonstrated that carbon dioxide fixation was dependent on the presence of an oxidizable substrate such as ferrous iron which provides the energy for reducing the carbon source. In the absence of ferrous iron, the bacteria culture was unable to fix carbon dioxide.

In a set of experiments designed to monitor bacterial activity in the absence of carbon dioxide, Beck (1960) found that iron oxidation continued and that neither the oxidation rate nor final iron level were affected. He interpreted the data to suggest that carbon dioxide fixation was not obligatory for ferrous iron oxidation. This observation was confirmed in the subsequent work by Beck and Shafia (1964) in which the effects of adding a known inhibitor, 2,4-dinitrophenol (DNP), to manometers containing sulphur or ferrous iron were investigated. The DNP was shown to completely prevent carbon dioxide fixation at a concentration of 10^{-5} moles but only partially inhibit the oxidation of the two substrates. Sulphur oxidation continued at a rate equal to about 10 percent of the rate measured before DNP addition while ferrous iron oxidation proceeded at a rate equal to approximately 20 percent of the unaffected rate.

Kelly and Jones (1978) carried out a series of shaker flask experiments to measure the effects of carbon dioxide limitation on the kinetics of ferrous iron oxidation. The results showed that with an ample supply of carbon dioxide (i.e. reactor open to the atmosphere) the ferrous iron was oxidized rapidly with the rate increasing exponentially, presumably in accordance with the typical bacterial growth curve. In the case when only a limited supply of carbon dioxide was left in the reaction flask, the ferrous iron oxidation rate changed from an initial exponential curve to a linear curve. The authors observed that carbon dioxide fixation occurred in direct proportion to the rate of ferrous iron oxidation and that depletion of the carbon dioxide supply coincided with the change to a linear rate of iron oxidation. In a third set of tests in which carbon dioxide was eliminated from the air space prior to the introduction of the bacteria to the growth substrate, the rate of ferrous iron oxidation was linear and much slower than observed in other experiments. These observations were interpreted to show that bacterial growth is uncoupled from iron oxidation as claimed by earlier investigators. MacDonald and Clark (1970) drew similar conclusions from batch culture studies in which the carbon dioxide level was both raised above the atmospheric level and lowered below the atmospheric level in separate sets of experiments.

Several researchers found that increasing the carbon dioxide level can increase the rate of oxidation of metal sulphides. In a series of shaker flash experiments, Torma et al (1972) observed the effect on zinc extraction of varying the carbon dioxide from 0.03 percent (i.e. the concentration in normal air) to 7.92 percent. Approximately a two-fold increase in the leach rate was measured as the carbon dioxide content was increased from 0.03 to 0.23 percent. Increasing the carbon dioxide content beyond 0.23 percent however, did not have additional benefit. The leach rate was found to increase from 360 to 640 mg.L^{-1}.hr^{-1} in the shaker flask tests. Operation of a 30 L unbaffled tank and a 12 L baffled tank with a 1 percent carbon dioxide content in the sparging air, yielded very similar zinc extraction rates of 635 and 651 mg.L^{-1}.hr^{-1} respectively. While the maximum zinc concentration observed in the shaker reactor solution was about 70 g.L^{-1}, levels of 112 and 119 g.L^{-1} were measured in the larger tank reactors.

T[illegible] f oxidation of the pyritic content of coal, ground to a [illegible] size of 43u to 74u and suspended as a 10 percent slurry, [illegible] assessed at carbon dioxide partial pressures in the gas phase of 0.032, 0.1, 1.0 and 10.0 percent (Hoffmann et al 1981). Only a slight increase in the reaction rate was observed. The maximum rate, measured at 10 percent carbon dioxide, was approximately 31 percent higher than the minimum rate, observed at 0.032 percent carbon dioxide.

Kelly and Jones (1978) in studying the effects of an unlimited carbon dioxide supply on ferrous iron oxidation in batch cultures determined that carbon dioxide fixation was proportional to iron oxidation at all ferrous iron concentrations studied. Furthermore, the growth yield coefficient was found to be independent of carbon dioxide concentration over the range 0.036 to 8.0 percent on a volume basis. Brown and Forshaug (1983) reported similar findings in batch culture studies with two T. ferrooxidans strains. Given an unlimited carbon dioxide supply, the cell yield per unit ferrous iron oxidized was fairly constant over a wide range in the initial iron concentration. However, in continuous culture experiments the data for one culture suggested a decreasing dependence of the cellular carbon content on the specific growth rate of the bacteria. That is, as the cell growth rate increased in response to increasing ferrous iron concentration in the feed, the carbon content in the cells apparently decreased. The cellular mass apparently did not decrease with increasing iron concentration as would be deduced assuming a constant cellular carbon content of 50 percent. The data for the second strain studied did not support the above findings although the scope of these latter investigations were considerably narrower (Brown and Forshaug 1983).

Assimilation of carbon dioxide by T. ferrooxidans grown on ferrous sulphate and lead sulphide media was examined in manometric oxidation experiments using several metal sulphide substrates (Silver and Torma 1974). The cells grown on both medium were found to fix carbon dioxide in the presence of ferrous sulphate, pyrite, chalcopyrite and red antimony trisulphide. The cells grown on lead sulphide were also able to use lead sulphide concentrate and galena as an energy source for the assimilation of carbon dioxide. Neither cell types were able to fix carbon dioxide in the presence of chalcocite, covellite, black antimony trisulphide, cobalt sulphide and nickel sulphide substrates. However, the cells grown on both medium were able to oxidize all substrates, although the extent of oxidation varied considerably. These results again demonstrate the uncoupling of bacterial growth from substrate oxidation.

Carbon dioxide fixation associated with the bacterial oxidation of reduced iron and uranium was measured by DiSpirito and Tuovinen (1982a) by the addition of radioactive sodium bicarbonate to vials containing a bacterial suspension and either ferrous sulphate or uranous sulphate enriched media. The uptake of carbon dioxide per milligram of bacterial protein content was measured at a pH of 1.5 and two substrate concentrations. The results indicated that on an equimolar substrate basis twice as much carbon was fixed during oxidation of uranous ion as compared to ferrous iron. This finding was found to comform with the number of electrons transferred; the oxidation of uranous ion (U^{4+}) to hexavalent uranium (U^{6+}) involves two electron transfers as compared to one electron transfer in the oxidation of ferrous iron (Fe^{2+}) to ferric iron (Fe^{3+}). The efficiencies of carbon dioxide fixation per electron pair were reportedly very similar equalling approximately 10.85 percent for uranium and 11.44 percent for iron oxidation. It was concluded therefore that oxidation of these substrates occurs by a similar electron transport system and coupling.

Summary: Carbon dioxide is essential for the growth of autotrophic bacteria. The evidence presented in the literature, primarily in relation to heap leaching research, has conclusively shown that bacterial activity can be increased by raising the carbon dioxide content in the gas phase. The optimum carbon dioxide content in the gaseous phase has been demonstrated to equal about 0.25 percent beyond which no further increase in bacterial growth occurs. The effect on bacterial activity of a limited carbon dioxide supply has not been as frequently studied.

Oxidation of pyritic material has been shown to proceed in the laboratory under conditions when bacterial growth is prevented by low carbon dioxide content in the gaseous phase. Whether or not carbon dioxide will limit bacterial oxidation of pyrite in the field is quite dependent on the geochemistry of the waste material. If the waste material contains a calcareous component, then an ample supply of carbon dioxide is likely to be available. If the waste material has been subject to an acid leach, as is the case with most uranium ores, then the tailings will have a low carbonate content unless limestone is subsequently added as an amendment. Further research is required to assess whether or not limiting the supply of carbon dioxide under continuous leach conditions will significantly reduce bacterial activity.

3.2.7 pH Dependence

Bacterial oxidation of pyritic material has been reported in section 2.0 to be promoted by a host of species with different species adapted to growth within specific pH regimes. As a consequence, bacteria have been implicated in pyrite oxidation over nearly the whole pH range from highly acidic to quite alakline. Bacterial catalysis of pyrite oxidation has been attributed primarily to T. ferrooxidans however, which is characterized by optimum growth in the acid pH range (i.e. pH 1.5 to 5.0). The pH range over which the growth of T. ferrooxidans is optimized has been shown to be dependent on the substrate.

In their initial work with T. ferrooxidans growth on modified 9K medium, Silverman and Lundgren (1959b) found the optimum pH range to be 2.5 and 4.2 with a peak oxidation rate occurring between 3.0 and 3.6. Schnaitman et al (1969) reported very similar findings for iron oxidation. The optimum pH range was 2.5 and 3.8. Outside this range the oxidation rate decreased quickly.

McGoran et al (1969) examined the oxidation of ferrous iron at pH values between 1.25 and 3.7 and found that no biological oxidation occurred at pH 1.3 and below. Bacterial oxidation was measurable at pH 1.4 and reached a maximum at pH 2.5 before declining to near zero again at pH 3.7. Recent work reported in the literature using T. ferrooxidans grown on ferrous iron, pyrite and sulphur mediums, shows a discontinuity in the bacterial ability to oxidize ferrous iron at pH 4.5 to 5.0 or above (Arkesteyn 1979). Other investigators have reported the optimum pH range for ferrous iron oxidation to be 2.5 to 3.0 (Malouf and Prater 1961, Razzell and Trussell 1963a) 2.5 to 3.5 (MacDonald and Clark 1970) and 2.3 to 2.7 (Tomizuka and Yagisawa 1978) which are in close agreement with the values reported previously.

On sulphur substrate, the rate of acid production by a T. ferrooxidans inoculum was constant over the pH range from 1.75 to 5.0 (McGoran et al 1969). Bacterial growth could not be established at initial pH values of either 1.75 or 6.0. Arkesteyn (1979) reported similar findings with the sulphur oxidation rate remaining essentially constant over the pH range from 2.8 to 7.0. Sulphur substrate samples inoculated with T. ferrooxidans cultures grown on ferrous iron, pyrite or sulphur mediums were shown to be oxidized with equal efficiency.

Using a pyrite substrate, Arkesteyn (1979) demonstrated that oxidation occurred at initial pH values above 5.0, albeit at a reduced rate. Bacteria grown on pyrite and sulphur medium oxidized pyrite substrate over the full pH range studied from 2.8 to 7.0. The T. ferrooxidans grown on ferrous iron medium oxidized pyrite less efficiently. Oxidation stopped at pH 6.0 and above in this set of experiments. At the other end of the spectrum the leach solution pH in pyrite oxidation studies has frequently been noted to reach a value between 2.0 and 3.0 within a few hours (Bryner et al 1954, Silverman 1967, Silver and Torma 1974).

Maximum copper dissolution from chalcopyrite ($CuFeS_2$) substrate was obtained by McGoran et al (1969) over an initial pH range of 1.8 to 3.5 in shaker flasks maintained at 35°C. The rate of leaching apparently declined below pH 1.2 and reached zero above pH 3.7. Oxidation of covellite (CuS) and chalcocite (Cu_2S) has been observed at pH values as high as 5.1 to 5.4 and 4.5 to 4.8, respectively (Silver and Torma 1974). Nielsen and Beck (1972) also found that oxidation of chalcocite stopped at a pH of 4.6. Resumption of chalcocite oxidation was reported by these investigators on the addition of acid. The optimum pH for oxidation of these copper sulphide minerals has been found to equal 1.7 to 2.3 for covellite and 2.3 for chalcocite (Sakaguchi et al 1976).

In shaker flask experiments using zinc sulphide (ZnS) concentrate ground to less than 38 μm particle size as the substrate, the optimum pH range for zinc leaching was found to be 2.0 and 3.0 (McGoran et al 1969). The minimum lag time to start of leaching occurred at a pH of 2.3. The maximum zinc extraction rate at the optimum pH of 2.3 and temperature of 35°C equalled about 350 to 400 $mg.L^{-1}.hr^{-1}$ at an optimum solids density of 13 to 16 percent (w/w basis). Torma et al (1970) reported very similar findings for shaker flask experiments of zinc extraction from zinc sulphide concentrate. At the optimum leach solution temperature of 35°C, the minimum lag time to start of oxidation occurred at pH 2.3. Zinc extraction was observed over the pH range of 1.5 to 4.0 with the maximum rate occurring at about pH 2.5. The maximum zinc dissolution rate was 350 to 450 $mg.L^{-1}.hr^{-1}$ at the optimum solids density of 16 percent (w/v basis) (Torma et al 1970).

The optimum pH for bacterial leaching of uranium ores mimics the findings for other metal sulphides. Tomizuka et al (1976) assessed the effect on uranium leaching of pH over the range from 1.7 to 2.5 and found the maximum leaching rate occurred at a pH of about 2.0. These same investigators established that the optimum pH for galena (PbS) oxidation similarly equalled 2.0 in bacterial leaching experiments carried out in essentially an iron free medium. When ferrous iron was present, the optimum pH was in the order of 3.0, or similar to that reported previously for ferrous iron oxidation.

Short term pyrite oxidation tests were reported by Le Roux et al (1973) for shaker flasks operated at a temperature of 30°C and an initial pH of 1.6. Bacterial oxidation of 90 percent pure pyrite, ground to less than 75 μm size was found to be 99.8 percent complete at the end of the test period, which varied from 12 to 16 weeks. The pH of the leach solution equalled approximately 0.8 in all flasks at the end of the experiments. A duplicate set of flasks operated under the same conditions except that a biocide was added to prevent bacterial activity, showed only 2 to 3 percent pyrite oxidation at the end of the test period. In long term experimental work using an 84 L pilot-scale leaching vessel, active pyrite oxidation by T. ferrooxidans was sustained over a pH range of 1.2 to 1.6. The reactor vessel pH was observed to increase or decrease in response to an increase or decrease in the feed rate. The iron content of the leach solution increased from the order of 2 to 3 $g.L^{-1}$ to 5 to 6 $g.L^{-1}$ as the feed rate was lowered over the course of the experiment (Le Roux et al 1973).

In microbial leaching tests designed to assess the effectiveness of mixed bacterial cultures in desulfurization of pulverized coal, the optimum pH was established to be between 2.0 and 2.5 (Dugan and Apel 1978). Hoffmann et al (1981) determined that the leach rate was independent of initial pH for pH values equal to or greater than 2.0 in coal slurry leaching experiments. For initial pH values greater than 3.5 there was an apparent increase in the lag time to start of oxidation. An initial pH of 1.5 was found to inhibit bacterial activity. The pH in all reactors exhibiting bacterial activity declined to a value between 1.9 and 2.3 within 10 days. These results are consistent with those previously reported for other substrates.

Summary: The initial pH at the start of leaching investigations has been shown to affect the lag time to start of oxidation. The minimum lag time occurs at a pH value close to the optimum value for leaching of the particular substrate. The optimum pH for leaching of most sulphidic substrates has been found to fall in the range from 1.6 to 2.5.

3.2.8 Temperature Dependence

The optimum temperature for growth of T. ferrooxidans has been investigated using several different substrates. Silverman and Lundgren (1959a) in their early work on development of an improved growth medium, found that the maximum growth rate on ferrous iron occurred at a temperature of 28°C. In subsequent manometer experiments using the improved ferrous iron medium, the optimum temperature was reported to be much higher at about 37°C (Silverman and Lundgren 1959b). Other investigators have reported the optimum temperature for ferrous iron oxidation to lie between 33 and 40°C (Malouf and Prater 1961, Landesman et al 1966, MacDonald and Clark 1970). Leaching studies on other metal sulphide ore and concentrate samples have demonstrated that the optimum temperature generally falls between 30 and 35°C. Optimum temperature reported in the literature include: 35°C for leaching chalcopyrite (Razzell and Trussell 1963a); 35°C for leaching a zinc concentrate (Torma et al 1970) and 29 to 34°C in uranium ore leaching investigations (Tomizuka et al 1976) to cite but a few examples.

The dependence of the rate of oxidation of sulphidic materials on temperature is well established. The common rule that a 10°C temperature rise results in a two-fold imcrease in bacterial activity has been demonstrated to be applicable to pyrite oxidation by T. ferrooxidans (Smith 1971, Paciorek et al 1980). Correction of the temperature effect on pyrite oxidation kinetics to account for actual conditions in full-scale field applications is recognized. Mathmatical models of dump leaching operations commonly incorporate a heat balance component (Cathles and Apps 1975, Cathles and Schlitt 1980, Davis and Ritchie 1982).

In heap leaching operations and waste dumps, the temperature may rise above the air temperature within the pile or dump due to bacterial activity. Harries and Ritchie (1981 and 1983) found the annual temperature to remain fairly constant within the waste rock dumps at Rum Jungle in northern Australia. In comparison to mean monthly air temperatures of 25 to 29.9 °C at Rum Jungle, temperatures of 32 to 37°C were consistently measured in the top 1 to 5 m of the waste rock piles. In hot spots at greater depth, temperatures up to 56°C were recorded.

Elevated temperatures within uranium tailings piles in the temperate climate of Canada are unlikely. Monitoring of the temperature variation within one of the inactive tailings management areas at Elliot Lake was undertaken over a depth of 0.1 to 5 m (Grenier and Bigu 1983). The temperature at shallow depth varied by 20°C whereas at the 5m depth the temperature varied by only 6°C. Comparison of the temperature measurements with predictions made using a simplified statistical macroclimatic model developed by Quellet for estimating soil temperatures gave good overall agreement. Heat generated during pyrite oxidation apparently was not significant.

Summary: The effect of temperature on bacterial activity is recognized. Most laboratory scale work is thus carried out at either 30°C or 35°C, the later temperature being used most often in leach tests. Correction of the kinetic rate data for field conditions is required.

3.2.9 Inhibitors

A large number of organic compounds are known to be inhibitory to the obligate chemolithotrophs. Among the most toxic compounds are the organic and amino acids (Martin 1978). A summary of concentration data for organic acids which are known to inhibit the growth of obligate chemolithotrophs are given in Table 3.1.

In addition to the above, a number of other organic and inorganic compounds are known to inhibit T. ferrooxidans activity. A partial listing of compounds which have been employed in one or more oxidation studies include:

- N-ethylmaleimide (NEM) has been employed to prevent oxidation of the sulphur moiety; a concentration of 1 mmole has been found to be effective (Beck and Brown 1968, Arkesteyn 1979)
- Sodium azide (NaN_3) has been used to inhibit oxidation of the ferrous iron component; a concentration of 10^{-2} mmoles was found to be inhibitory (Beck and Brown 1968, Arkesteyn 1979)
- 2,4 dinitrophenol (DNP) to prevent the oxidation of both the ferrous iron and sulphur components was reportedly only partially successful at a concentration of 10^{-1} mmoles (Beck and Shafia 1964). Carbon dioxide fixation was prevented at a concentration of 10^{-2} mmoles

TABLE 3.1

Organic Acids Inhibitory to the Growth of Obligate Chemolithotrophs

Organic Acid	Inhibitory Concentration (mmoles/L)	Organism Affected
Acetate	0.1	T. thiooxidans
	> 1	T. neapolitanus
	10	T. ferrooxidans
	10 to 25	T. denitrificans
Butyrate	10	T. ferrooxidans
Citrate	0.1	T. thiooxidans
	10 to 50	T. denitrificans
Dihydroxyfumarate	0.02	T. thiooxidans
Formate	10	T. ferrooxidans
	5 to 25	T. denitrificans
Fumarate	10	T. ferrooxidans
Hexanoate	10	T. ferrooxidans
Hydroxypyruvate	0.02	T. thiooxidans
Isocitrate	0.1	T. thiooxidans
Itaconate	0.02	T. thiooxidans

Table 3.1 (cont'd)

Organic Acid	Inhibitory Concentration (mmoles/L)	Organism Affected
- Ketoglutarate	0.1	T. thiooxidans
	1	T. neapolitanus & T. denitrificans
Lactate	10 to 50	T. denitrificans
Malate	0.1	T. thiooxidans
	10	T. ferrooxidans
Malonate	0.02	T. thiooxidans
Oxaloacetate	10	T. ferrooxidans
	20	T. denitrificans
Propionate	10	T. ferrooxidans
Pyruvate	0.04 to 1	T. thiooxidans
	2 to 10	T. ferrooxidans
Succinate	0.01 to 1	T. thiooxidans
	2 to 10	T. ferrooxidans
	>2	T. neapolitanus
Transaconitate	0.1	T. thiooxidans
Valerate	10	T. ferrooxidans

*Taken from summary presented by Matin (1978)

- Panacide, a biocide, was found to be quite effective as a bacterial inhibitor (Le Roux et al 1973).
- Sodium lauryl sulphate (SLS), an anionic detergent, has been found to be effective in blocking bacterial activity (Kleinmann et al 1981, Olem et al 1982).
- Acriflavine, an antiseptic, has been employed to inhibit the activity of sulphur oxidizing bacteria (Gleason et al 1978)
- Calcium formate was used to inhibit bacterial activity (Kugatow 1977)
- Dodecylbenzenesulfonate (DBS) a detergent, has proven to be particularly inhibitory to ferrous iron oxidizing bacteria (Kugatow 1977)
- Fructose, lactose, meat extract, yeast extract, peptone and tryptone completely inhibited bacterial activity at a concentration of 0.5 percent (w/v basis) (Tuovinen et al 1971)
- Chloride and nitrate inhibited bacterial activity when present in high concentrations (Tuovinen et al 1971)

Certain of these compounds, notably the detergent based compounds DBS and SLS, have been tested in the laboratory and the field as agents for inhibiting acid production from pyritic material. The degree of success reported in the literature varies considerably.

Due to the complexity of acid formation within a coal mine environment, inhibitors have not been shown to be effective in preventing acid production (Gleason et al 1978). The most accepted method for minimizing acid formation involves flooding to retard the diffusion of oxygen to the pyritic material.

In field plots established in three strip-mined areas, DBS detergent was observed to be effective in reducing the number of iron-oxidizing bacteria except in very acidic soils (Kugatow 1977). Sulphur-oxidizing bacteria were not affected however, and even the iron-oxidizing bacteria were seen to recover within only a few weeks. More significantly, none of the inhibitory treatments had any measureable effect on either pH or total acidity in the drainage water from the plots.

In controlled laboratory column studies in which the effects of adding anionic detergent were investigated, Olem et al (1982) determined that SLS detergent added as a slug at a concentration of 50 $mg.L^{-1}$ in the feed water to the columns prevented acid formation for a period of approximately 60 days. Neutralized benzene sulfonate (NBS) was also tested but found to be much less effective.

Kleinmann et al (1981) determined in laboratory experiments that SLS was effective in killing iron oxidizing bacteria at a concentration of 25 $mg.L^{-1}$ and thus set about developing a slow release formulation for use in field applications. A vulcanized rubber compound provided the desired release characteristics and was subsequently adopted for field testing. Investigations at two coal refuse piles, designed with underdrainage collection systems, in which one pile was treated with slabs of the detergent formulation, reportely proved to be partially successful. An initial 80-fold difference in acidity and iron levels between the two piles however had declined to a 3-fold difference within five months. The desired detergent concentration apparently was not achieved in the coal pile drainage. In field experiments at an abandoned surface mine, a pronounced reduction in the acidity level was achieved over a considerably longer time period. At a detergent concentration of 20 to 60 $mg.L^{-1}$ in runoff from the test field, the acidity level equalled only about 5 percent of that measured before addition of the vulcanized rubber formulation. The authors estimated that the detergent treatment could potentially remain effective for 2 to 5 years.

Summary:

Obligate chemolithotrophic bacteria are particularly susceptible to several organic compounds, particularly the organic and amino acids. Several organic type inhibitors have been employed in controlled laboratory oxidation investigations. Interest in the use of anionic detergents, particularly sodium lauryl sulphate (SLS), for treatment of existing acid mine drainage problems, such as runoff from strip-mine areas, and prevention of potential acid sources, drainage from coal storage piles for example, has been stipulated. The applicability of this approach in complex environments, such as underground mines, remains to be demonstrated. At best, the bacterial inhibitors present a short term solution until more permanent reclamation measures are either developed or implemented.

4.0 ENVIRONMENTAL EFFECTS AND RADIONUCLIDE CHEMISTRY

4.1 Introduction

Uranium mineralization has been identified throughout Canada, with the primary commercial deposits located in Ontario and Saskatchewan. Other areas with development potential include British Columbia, Nova Scotia, Newfoundland, and the Northwest Territories. The mineralogy of these deposits varies greatly. There are considerable differences in the radionuclide composition and heavy metal content. In addition some deposits have a significant arsenic content while other deposits contain substantial amounts of sulphidic material. The implications of bacterially mediated pyrite oxidation are thus quite different from one deposit to another.

In this section, the nature of the principal uranium deposits is reviewed. In addition, the implications of bacterially assisted pyrite oxidation on the mobilization of contaminants in the tailings piles is discussed. Environmental factors which have an important bearing on bacterial activity are reviewed. Finally, the potential effects of alternative tailings closeout management strategies on microbial activity and contaminant mobilization are briefly discussed.

4.2 Uranium Deposit Characteristics

4.2.1 Ontario Deposits

Elliot Lake

Uranium in the Elliot Lake area is associated with a quartz pebble conglomerate and is present mainly as brannerite, uraninite and monozite. The deposits typically contain 0.1 percent uranium and have a moderate pyrite content in the range of 2 to 8 percent (OWRC 1972). The radionuclides in the deposit are in secular equilibrium (MacLaren 1977) and the heavy metals (in particular copper, lead, zinc) are typically found in low concentrations (Moffett 1980). Tailings and waste rock from the operations are known to be significant acid generators.

Bancroft

Uranium in the Bancroft area occurs in pegmatitic granite dykes with the principal minerals being uraninite and uranithorite (OWRC 1972). The metal sulphide content of these ores is typically low. As a result production of acidic runoff and leaching of radionuclides and heavy metals are generally not a problem.

4.2.2 Saskatchewan Deposits

Cluff Lake

Uranium from the 'D' zone at Cluff Lake is associated with sedimentary pellites and generally occurs as uraninite-pitchblends and coffinite (Stearns-Rogers 1976). The deposit contains high levels of lead and radium but little pyrite. Acid generation is not considered to be a concern.

Rabbit Lake

Uranium from Rabbit Lake is contained in a siliceous dolomite and generally occurs as pitchblende and uranophene. Only a small amount of sulphidic material is present and the tailings are non-acid generating (Gulf Minerals 1973).

Collins "B"

Uranium at Collins 'B' is contained in a large pod within the Athabasca sandstone formation. This uranium ore is a much higher grade deposit than that found at Rabbit Lake. The 'B' zone contains low levels of sulphide (0.1 percent) arsenic, nickel, molybdenum and other trace metals (Gulf Minerals 1980 and 1981). The tailings are not considered to be acid generators (Gulf Minerals 1981). The characteristics of the Collins 'B' deposit are believed to be indicative of the minerology of several other local deposits such as the Dawn Lake, Midwest Lake, Cigar Lake and McClean Lake deposits.

Key Lake

Uranium from Key Lake is associated with horizontal beds of sandstone, kaolinized residual rock and a sequence of biotite gneiss. The principal minerals are pitchblende and coffinite. Like Collins 'B', the deposit has a low sulfide mineral content. The Key Lake deposit however contains elevated levels of nickel and arsenic (Key Lake 1979).

Beaverlodge

Uranium in the form of pitchblende and coffinite was mined at Beaverlodge (MacLaren Plansearch 1983). Although pyrite is a common mineral in the ore, there is sufficient alkalinity in the host rock to neutralize any acid produced from oxidation of the pyritic material.

Gunnar and Lorado

Gunnar and Lorado are two abandoned uranium properties in the Uranium City area. The Gunnar tailings do not contain a significant amount of pyrite and therefore are non-acid producing. The Lorado tailings in contrast, contain sufficient pyrite to produce acidic runoff (Swanson and Abougendia 1981).

4.3 Effects of Bacterial Oxidation on Contaminant Release

4.3.1 General

Bacterial oxidation of tailings with a high sulphide content generally results in the production of net acidity and the consequent release of both metallic and non-metallic elements. The contaminants are released as a result of the drop in pH which enhances the dissolution of previously insoluble metallic compounds. Certain constituents such as arsenic may be released directly due to the bacterial oxidation of sulphide compounds comprised of the constituents, for example arsenopyrite. Arsenopyrite is readily oxidized by T. ferrooxidans.

Many of the metal constituents released from uranium tailings are typical of the contaminants found in acid mine drainge from base metal, coal and gold mines and include copper, lead, nickel, zinc and iron. Mobilization of the radionuclides in uranium mine tailings is an additional issue of particular interest. The solubility of uranium, thorium and lead is related to pH whereas the solubility of radium is more dependent upon the chemistry of the associated co-precipitates within the tailings material. An abbreviated discussion on the chemistry of uranium, thorium, lead and radium follows.

4.3.2 Uranium

Although several oxidation states of uranium are known, only U(IV) and U(VI) are usually found under natural conditions. Uranium in other oxidation states, for example aqueous solutions of U(V), disproportionate to U(IV) and U(VI) species (Ames and Rai 1978):

$$2UO_2^{+} + 4H^{+} \rightarrow UO_2^{2+} + U^{4+} + 2H_2O \qquad (4.1)$$

The solution chemistry of uranium minerals and the formation of aqueous complexes have been reviewed by Langmuir (1978), Ames and Rai (1978) and Lemire and Tremaine (1980). In the presence of oxygen (for example, in the oxidizing zone of a tailings area) U(IV) minerals are unstable and are oxidized to uranyl ion. In an acidic environment, either oxygen or ferric iron serve as oxidants according to the following reactions:

$$2UO_2(s) + 4H^+ + O_2 \rightarrow 2UO_2^{2+} + 2H_2O \qquad \text{Log } K = 55.4 \qquad (4.2)$$

$$UO_2(s) + 2Fe^{3+} \rightarrow UO_2^{2+} + 2Fe^{2+} \qquad \text{Log } K = 18.73 \qquad (4.3)$$

At the typical contaminant concentrations measured in the acidic porewater of the oxidizing zones of Elliot Lake tailings (Table 4.1), oxidation by reaction mechanism (4.2) is thermodynamically favoured. The rate of uranyl (UO_2^{2+}) ion formation however, may be higher by reaction (4.3).

The solubility products of the common U(VI) minerals are summarized in Table 4.2. The solubility products (K_{sp}) for the oxides have been obtained from data provided by Lemire and Tremaine (1980). Solubility products for autinites (uranyl phosphates) were calculated from Gibbs free energy data compiled by Langmuir (1978) and Stumm and Morgan (1981). The data for the vanadates have been obtained from Langmuir (1978). Uranyl vanadates, particularly carnotite ($K_2(UO_2)_2(VO_4)_2$), are the least soluble U(VI) minerals. In general, autinites appear to follow in solubility, while uranyl oxides and hydroxides are the most soluble minerals.

At pH values of 3.0 and below, none of the U(VI) minerals are stable and equilibrium UO_2^{2+} concentrations exceed 500 mg.L^{-1}. In addition, UO_2^{2+} readily complexes to form soluble ligands with hydroxide (OH^-), carbonate (CO_3^{2-}) and sulphate (SO_4^{2-}). The most important complexation reactions are summarized in Table 4.3. The formation of these inorganic ligands greatly enhances the solubility of U(VI) minerals. In an acidic environment at pH values of 3.0 and below, UO_2^{2+} and UO_2SO_4 (aq) are the predominant species. At pH values near neutrality, $UO_2(OH)^+$, $UO_2(OH)_2$(aq)

TABLE 4.1

Porewater Contaminant Levels in the Oxidizing and Non-Oxidizing Zones of Elliot Lake Tailings

Parameter	Measurement Units	Typical Range Oxidizing Zone	Typical Range Non-oxidizing Zone
pH	-	1-3	5-7
Acidity	mg/L $CaCO_3$	2000-10000	2000-12000
Cu	mg/L	0.1-0.3	<0.1
Pb	mg/L	0.5-2	<0.1-1
Ni	mg/L	2-20	0.3-1
Zn	mg/L	1-10	0.5-2
Fe^{2+}	mg/L	500-2000	500-3000
Fe^{3+}	mg/L	100-1000	<10
Mn	mg/L	2-40	2-40
SO_4	mg/L	2000-10000	2000-12000
Pb-210	pCi/L	no data	<.5
Th-230	pCi/L	1000-10000	<50
Ra-226	pCi/L	50-200	50-200
U	mg/L	1-10	<1

TABLE 4.2

Dissolution Equilibria of U(VI) Minerals

Dissolution Reaction	Equilibrium constant at 25°C (log K_{sp})
$\gamma\text{-}UO_3+2H^+=UO_2^{2+}+H_2O$	7.7
$\beta\text{-}UO_2(OH)_2+2H^+=UO_2^{2+}+2H_2O$	5.7
$UO_3-2H_2O+2H^+=UO_2^{2+}+3H_2O$	5.6
$2U_3O_8+12H^++O_2=6UO_2^{2+}+6H_2O$	70.0
$H_2(UO_2)_2(PO_4)_2=2UO_2^{2+}+2H^++2PO_4^{3-}$	-48.2
$Na_2(UO_2)_2(PO_4)_2=2UO_2^{2+}+2Na^++2PO_4^{3-}$	-34.5
$K_2(UO_2)_2(PO_4)_2=2UO_2^{2+}+2K^++2PO_4^{3-}$	-35.4
$(NH_4)_2(UO_2)_2(PO_4)_2 = 2UO_2^{2+}+2NH_4^++2PO_4^{3-}$	-39.1
$Mg(UO_2)_2(PO_4)_2=2UO_2^{2+}+Mg^{2+}+2PO_4^{3-}$	-31.2
$Ca(UO_2)_2(PO_4)_2=2UO_2^{2+}+Ca^{2+}+2PO_4^{3-}$	-31.5
$Ba(UO_2)_2(PO_4)_2=2UO_2^{2+}+Ba^{2+}+2PO_4^{3-}$	-31.7
$Fe(UO_2)_2(PO_4)_2=2UO_2^{2+}+Fe^{2+}+2PO_4^{3-}$	-31.8
$Cu(UO_2)_2(PO_4)_2=2UO_2^{2+}+Cu^{2+}+2PO_4^{3-}$	-32.2
$Pb(UO_2)_2(PO_4)_2=2UO_2^{2+}+Pb^{2+}+2PO_4^{3-}$	-31.8
$K_2(UO_2)_2(VO_4)_2=2UO_2^{2+}+2K^++2VO_4^{3-}$	-56.9
$Ca(UO_2)_2(VO_4)_2=2UO_2^{2+}+Ca^{2+}+2VO_4^{3-}$	-53.4

TABLE 4.3

Uranium (VI) Complexation Reactions

Reaction	Equilibrium Constant (Log K)
$UO_2^{2+}+H_2O=UO_2(OH)^++H^+$	-5.8
$UO_2^{2+}+2H_2O=UO_2(OH)_2(aq)+2H^+$	-12.1
$2UO_2^{2+}+2H_2O=(UO_2)_2(OH)_2^{2+}+2H^+$	-5.6
$UO_2^{2+}+CO_3^{2-}=UO_2CO_3(aq)$	10.1
$UO_2^{2+}+2CO_3^{2-}=UO_2(CO_3)_2^{2-}$	17.1
$UO_2^{2+}+3CO_3^{2-}=UO_2(CO_3)_3^{4-}$	21.4
$UO_2^{2+}+SO_4^{2-}=UO_2SO_4(aq)$	2.9
$UO_2^{2+}+HPO_4^{2-}+H^+=UO_2H_2PO_4^+$	10.2
$UO_2^{2+}+2HPO_4^{2-}+2H^+=UO_2(H_2PO_4)$ (aq)	19.9

become the most important ligands, while in the alkaline pH range, the anionic carbonato complexes ($UO_2(CO_3)^{2-}$, $UO_2(CO_3)^{4-}$) are present in significant concentrations.

The data on soluble uranium concentrations in the oxidizing zone of tailings of 1 to 10 mg.L^{-1} suggest that the kinetics of U(IV) oxidation, rather than U(VI) equilibrium are limiting dissolved uranium concentrations, since the soluble UO_2^{2+} levels are far below equilibrium predictions. In acid mine waters, much higher uranium levels of 50 to 100 mg.L^{-1} are not unusual (MacLaren 1977, MacLaren Plansearch 1983).

Under reducing conditions, the concentration of uranium is governed by the dissolution of U(IV) minerals. As shown in Table 4.4, uraninite (UO_2) and coffinite are relatively stable under acidic conditions. In the redox zone, U^{4+}, uranous sulphato (USO_4^{2+}, $U(SO_4)_2$ (aq)) and fluoride complexes would predominate at pH values below 4.0 and uranous hydroxy ligands at pH values near neutrality. The total dissolved uranium concentrations would be considerably below 1 mg.L^{-1} at pH values above 3.0. The data on tailings porewater chemistry suggest that uranium concentrations may be governed by U(IV) dissolution and complexation equilibria in the redox zone.

4.3.3 Thorium

Thorium mobilization from tailings deposits is highly dependent on pH. Unlike uranium, thorium exists only as Th^{4+} under natural conditions and it is normally found as an hydroxide in tailings deposits. Other mineral forms such as monozite may be present but are generally considered quite recalcitrant to leaching.

The dissolution equilibria and the most important complexation reactions have been compiled from Sillen and Martell (1964) and

TABLE 4.4

Dissolution Equilibria and Complexation Reactions of Uranium (IV)

Reaction	Equilibrium Constant (Log K)
$UO_2(s)+4H^+ = U^{4+}+2H_2O$	-4.6
$U^{4+}+H_2O = U(OH)^{3+}+H^+$	-1.0
$U^{4+}+2H_2O = U(OH)_2^{2+}+2H^+$	-2.0
$U^{4+}+SO_4^{2-} = USO_4^{2+}$	5.0
$U^{4+}+2SO_4^{2-} = U(SO_4)_2(aq)$	10.0
$U^{4+}+HPO_4^{2-} = UHPO_4^{2+}$	12.0
$U^{4+}+2HPO_4^{2-} = U(HPO_4)_2\ (aq)$	22.0
$U^{4+}+Cl^- = UCl^{3+}$	3.0
$U^{4+}+F^- = UF^{3+}$	9.0
$U^{4+}+2F^- = UF_2^{2+}$	14.0
$U^{4+}+3F^- = UF_3^+$	19.0
$U^{4+}+4F^- = UF_4(aq)$	24.0

are presented in Table 4.5. Above pH 5.0, the solubility of thorium is very low and essentially constant. Below pH 5.0, the solubility of thorium is pH dependent. Thorium readily complexes to form soluble hydroxy ligands at relatively low pH values. At pH values between 3.0 and 5.0, these complexes are present as colloids. In a very acidic environment, the hydroxy and sulphato ligands would predominate.

Little data are available on the levels of thorium in tailings porewaters, runoff or seepage. The primary thorium isotope of concern is thorium-230. Typical levels under acid conditons are believed to be in the order of 1000 to 10,000 $pCi.L^{-1}$. As the pH is raised to 5.0 and above the Th-230 level drops to below 50 $pCi.L^{-1}$. Studies performed by CANMET at the Nordic tailings site indicate porewater levels in the saturated zone of the tailings and in the groundwater regime below the tailings are typcially less than 50 $pCi.L^{-1}$ (Dave 1984).

4.3.4 Lead

In the high sulphate environment of pyritic tailings, lead sulphate may exist as a stable solid phase. The solubility of lead sulphate and the complexation of Pb^{2+} are summarized in Table 4.6. The database has been derived from Stumm and Morgan (1981) and Sillen and Martell (1964). At low pH values, Pb^{2+} and the sulphato complex ($PbSO_{4(aq)}$ are the predominant species. At pH values above 6.0, the solubility is probably a complex function of pH and dissolved carbon dioxide. Speciation as $PbOH^{+}$, $PbCO_3(aq)$ and $PbHCO_3^{-}$, becomes important at near neutral pH values.

The isotope lead-210 oxides and carbonates are readily mobilized by acid conditions in tailings deposits. At neutral pH levels lead solubility is in the range of 0.01 to 0.1 $mg.L^{-1}$ but

TABLE 4.5

Dissolution Equilibria and Complexation Reactions of Thorium

Reaction	Equilibrium Constant at 25°C (Log K)
$Th(OH)_4(s)=Th^{4+}+4OH^-$	43.09
$Th(OH)_4(s)+H^+=Th(OH)_3^++H_2O$	1.51
$Th(OH)_4(s)+H_2O=Th(OH)_5^-+H^+$	-5.80
$Th(OH)_4(s)+2H_2O=Th(OH)_6^{2-}+2H^+$	-5.80
$Th^{4+}+H_2O=Th(OH)^{3+}+H^+$	-3.89
$Th^{4+}+2H_2O=Th(OH)_2^{2+}+2H^+$	-7.00
$Th^{4+}+4H_2O=Th(OH)_4(aq)+4H^+$	-11.00
$Th^{4+}+SO_4^{2-}=ThSO_4^{2+}$	3.11
$Th^{4+}+2SO_4^{2-}=ThSO_4^0$	2.47
$Th^{4+}+Cl^-=ThCl^{3+}$	1.38
$Th^{4+}+2Cl^-=ThCl_2^{2+}$	1.03
$Th^{4+}+3Cl^-=ThCl_3^+$	-0.51

TABLE 4.6

Dissolution Equilibria and Complexation Reactions of Lead

Reaction	Equilibrium Constants at 25°C (Log K)
$PbSO_4(s)=Pb^{2+}+SO_4^{2-}$	-7.75
$Pb^{2+}+H_2O=Pb(OH)^{+}+H^{+}$	-6.48
$Pb^{2+}+2H_2O=Pb(OH)_2^{0}+2H^{+}$	-17.46
$Pb^{2+}+3H_2O=Pb(OH)_3^{-}+3H^{+}$	-28.10
$Pb^{2+}+CO_3^{2-}=PbCO_3^{0}$	5.20
$Pb^{2+}+HCO_3^{-}=PbHCO_3^{-}$	4.77
$Pb^{2+}+SO_4^{2-}=PbSO_4^{0}$	2.29
$Pb^{2+}+Cl^{-}=PbCl^{+}$	1.16
$Pb^{2+}+2Cl^{-}=PbCl_2^{0}$	2.44

increases rapidly to several thousand mg.L^{-1} at pH levels below 4.0. In high sulphate, low pH porewater however, the dissolved lead-210 may precipitate as a solid solution with lead as lead sulphate. Few data on lead-210 levels in porewater have been collected. It is worthy to note that lead-210 is a solid daughter product of radon gas. As such, lead-210 is formed along the entire migration pathway of its gaseous parent.

4.3.5 Radium

In tailings porewater, radium concentrations have been consistently observed to be several orders of magnitude less than predicted from solubility equilibria of $RaSO_4$ ($K_{sp}=10^{-10.37}$). It is likely, that much of the radium occurs in solid solutions of $BaSO_4$ and $CaSO_4$ (gypsum) where radium has displaced barium or calcium in the crystal lattices of the host mineral. Thus, the solubility of radium is dependent on both the mole fraction of radium and the solubility product of the host mineral. Radium does not appear to form complexes with anions (Ames and Rai 1978).

Radium levels in porewaters from tailings areas do not appear to be greatly affected by pyrite oxidation or acid production. In fact there is some indication that radium solubility is inversely proportional to the sulphate level rather than pH in tailings deposits. Radium activities are highly variable but tend to fall between 50 and 200 pCi.L^{-1} in sulphidic tailings (Cherry et al 1980). These observations are consistent with the hypothesis of solid solutions of radium in $BaSO_4$ and $CaSO_4$.

4.4 Environmental Implications of Pyritic Tailings

4.4.1 Overview

Surface runoff characteristics from tailings areas reflect the chemical and bacterial reactions occurring in the near surface oxidizing zone above the water table. At near neutral pH bacterial activity plays a minor role in the oxidation of sulphidic material. As the pH level drops, the microbial activity greatly catalyzes acid production, resulting in the formation of highly acidic tailings porewater containing elevated levels of the radionuclide and metal contaminants, the specific contaminants of importance being dependent on the geochemistry of the tailings. Ferric iron is generally the dominant metal species.

As the pyritic material is depleted from the surface layer (i.e. oxidizing zone) the rate of acid production will decline. Eventually surface runoff quality could return to near neutral conditons and contain only low concentrations of most contaminants.

The major long term source of acidity would then be subsurface seepage. A number of investigators have studied extensively porewater quality and subsurface contaminant migration from the acid generating Elliot Lake tailings (Feenstra et al 1981, Blair et al 1980, Cherry et al 1980 and 1983, Kaiman 1977, Morin et al 1982, Smyth et al 1981). Few if any studies are available on porewater quality and subsurface contaminant migration from acid generating tailings in Saskatchewan. The only inactive site in western Canada which contains high pyritic tailings is the Lorado tailings disposal site. Future tailings from Key Lake, Collins 'B' and others could possibly be affected by biological mediated sulphide oxidation. A brief discussion regarding the short and long term environmental consequences of pyritic uranium tailings management in Elliot Lake and Saskatchewan follows.

4.4.2 Elliot Lake Tailings

Elliot Lake mills use acid leach circuits which produce tailings with essentially none of the original hard rock alkalinity remaining. Some alkalinity is added to the tailings in the mills as either lime or limestone to raise the pH to the 9 to 10 range before disposal in the tailings management areas. The tailings have a net acid production potential however due to the occurrence of a substantial amount of pyritic material.

In the alkaline pH range (i.e. from pH 7 to 10) the pyritic material oxidizes chemically at a low but significant rate (Cherry et al 1983, SENES 1984). It is hypothesized that bacterial activity does not contribute significantly to the acid generation in this pH range unless elemental sulphur or thiosalts are present (Arkesteyn 1980). Since chemical oxidation of ferrous iron is very rapid above pH 7 and ferric iron is almost instantaneously precipitated from solution as an hydroxide, the rate of pyrite oxidation is controlled at a low rate by the loss of the primary oxidant, ferric iron.

With the Elliot Lake tailings, the alkalinity added is rapidly depleted once tailings deposition ceases and the pH declines rapidly in the surface zone. Once the pH drops below the 6 to 7 range, bacterial oxidation starts to play a more important role. In the pH range from 4 to 6 the oxidation of ferrous sulphate is followed by the precipitation of ferric hydroxides which acts to further depress the pH. Once the pH declines to about 2.5 the rate of pyrite oxidation due to microbial activity reaches a peak. The ferric iron which stays in solution in the acid pH range acts as the primary oxidant in the chemical oxidization of pyrite producing more ferrous iron which is biologically oxidized to produce more ferric iron and so on.

As the acidic porewater from the oxidizing zone moves downward into the non-oxidizing zone several geochemical reactions occur.

Hydronium ions are consumed by residual hydroxides and in the oxidation of the sulphide moiety of pyrite to elemental sulphur. This later reaction is represented by the equation:

$$2Fe(OH)^{2+}+2H^{+}+FeS_2 \rightarrow 3Fe^{2+}+2S^{\circ}+2H_2O \qquad (4.4)$$

As indicated by this equation there is an upward shift in pH in the non-oxidizing zone.

Porewater quality in the oxidizing zone is characterized by high acidity and high levels of dissolved metals and radionuclides. A typical analysis of porewater quality for both oxidizing and non-oxidizing tailings was provided previously in Table 4.1. Porewater quality in the non-oxidizing zone is characterized by near neutral pH and lower levels of the heavy metals and most radionuclides. Because radium-226 behaviour is not influenced substantially by pyrite oxidation, it is typically found in nearly equal levels in oxidizing and non-oxidizing tailings porewaters.

4.4.3 Saskatchewan Tailings

The Saskatchewan ores are processed using acid leach technology similar to that used in Ontario. Concerns with heavy metal and radionuclide dissolution are also similar except that additional contaminants such as arsenic , molybdenum and nickel may be leached from the tailings material. These deposits contain low levels of metal sulphides, thus it is unlikely that sufficient pyrite is present to be of a long term concern with respect to acid production or metal and radionuclide leaching (Stearns-Rogers 1976, Gulf Minerals 1981).

4.5 Modelling of Pyrite Oxidation Processes

The chemistry of pyrite oxidation is recognized to be extremely complex but has been described frequently in the literature by the following stoichiometric equations:

$$FeS_2(s)+7/2O_2+H_2O \rightarrow SO_4^{2-}+Fe^{2+}+2H^+ \qquad (4.5)$$

$$Fe^{2+}+1/4O_2+H^+ \rightarrow Fe^{3+}+1/2H_2O \qquad (4.6)$$

$$FeS_2(s)+14Fe^{3+}+8H_2O \rightarrow 15Fe^{2+}+2SO_4^{2-}+16H^+ \qquad (4.7)$$

These relationships apply to acid conditions (i.e. pH less than 2.5). At higher pH values, the ferric iron formed in equation (4.6) precipitates rapidly from solution and equation (4.7) is replaced by the following relationship:

$$Fe^{3+}+3H_2O \rightarrow Fe(OH)_3(s)+3H^+ \qquad (4.8)$$

While the above equations define the primary reactants and products, they do not identify possible intermediate reactions, reaction mechanisms nor reaction kinetics. The equations do point out the importance however of oxygen and ferric iron as oxidants in the reaction sequence as previously noted elsewhere in this report.

Modelling of pyritic systems has frequently incorporated terms describing the transport of oxygen which has generally been considered the rate-controlling step. The models developed by researchers from the Ohio State University Research Foundation for assessing acid mine drainage and abatement strategies for coal mining operations are typical examples of models which consider the importance of oxygen as a limiting reactant (Shumate et al 1971, Shumate and Brant 1971, Morth et al 1972). Oxygen transport to the reaction sites in heap leaching operations (Cathles and Apps 1975, Cathles and Schlitt 1980) and waste rock piles (Daniel et al 1981a, Harries and Ritchie 1981 and 1983, Davis and Ritchie 1982) is recognized to be an important factor in modelling the leaching processes.

Jaynes et al (1984a and 1984b) recently reported efforts to model acid mine drainage from reclaimed coal strip mines. These researchers developed and tested a comprehensive model for simulating several key parameters and found that simulated results fell well within the range of measured values. Oxygen was found to be the only important oxidant of pyrite in systems free of iron-oxidizing bacteria and the oxidation of ferrous to ferric iron by purely chemical means was shown to be too slow to affect the overall pyrite oxidation rate. Most significantly, the diffusion rate of oxygen was evaluated to be the primary factor controlling the rate of pyrite oxidation. Very similar conclusions were reached by the authors of this report in previous investigations which involved modelling the pyrite oxidation processes in uranium tailings (Halbert et al 1982 and 1983). It was consequently proposed that the placement of pyritic tailings below water (either by flooding or raising the water table) represents a promising method for controlling the rate of pyrite oxidation and thus rectifying an environmental concern.

The analyses of the various investigators noted above are based on the premise that the rate of microbially mediated pyrite oxidation is dependent on the availability of oxygen. In most models, a zero order dependence of the bacterial oxidation rate on oxygen concentration is assumed. The effect of low oxygen concentration on bacterial population dynamics and activity, however, has not been conclusively established. The reported effectiveness of flooding coal mines in reducing the acid loading lends support to the concept that limiting the oxygen supply will limit the extent of pyrite oxidation (Gleason et al 1978). Conversely, the apparent proliferation of thiobacilli at low dissolved oxygen levels in uranium waste rock piles (Daniel et al 1981a, Harries and Ritchie 1983) and in the saturated base below coal refuse piles (Schubert and Miller 1982) requires further research on bacterial activity at low dissolved oxygen concentrations.

4.6 Tailings Closeout Options

4.6.1 General

In is commonly accepted that the control of acid production from sulphidic uranium tailings is the principal long term management concern due to the pronounced effect it has on the release of radionuclides to the environment. Several concepts have been put forth for the closeout of tailings areas, all of which address the concern noted above to varying degrees. The concepts include:

- direct vegetation
- cover
- pyrite removal
- limestone addition
- flooding

The potential ramifications of any of these options are quite site specific. However, a general review of the effects of bacterial oxidation on each of the waste management concepts follows.

4.6.2 Environmental Implications of Closeout Concepts

Vegetation

Vegetation has gained acceptance as a viable method for stabilizing tailings surface areas. It has also been hypothesised that vegetation could markedly reduce acid generation rates by limiting the transport of oxygen into the tailings mass. The concept assumes development of an organic mat that will consume oxygen. The potential benefits of vegetation on reducing acid production and contaminant mobilization have not been substantiated.

Based upon the work of Smyth et al (1981), the oxygen level in the pore space within the tailings mass declines rapidly in the top 1 to 2 m from 20 percent to less than 2 percent. These findings concur with those reported by Australian researchers (Daniel et al 1981a, Harries and Ritchie 1983) for a uranium waste rock dump at Rum Jungle. The data suggest that oxygen may very well be a limiting nutrient in the surface zone. However, the role that vegetation plays in reducing the oxygen flux, if any, is not apparent from the data.

Pyrite Removal

Reduction of the pyrite content by up to 95 percent can be achieved using pyrite flotation technology. Even so, the residual pyrite in the tailings will oxidize and if sufficient alkalinity is not present to neutralize the acid produced, then acid conditions will evolve. Means of managing the substantial volume of pyrite concentrate produced so as to minimize acid generation would be required and could present an even more difficult problem.

Limestone Addition

Limestone addition to the tailings mass to maintain a neutral pH is a potentially effective means of minimizing acid production in the short term at least. Bacterial oxidation of sulphidic material would not likely play a significant role in limestone treated tailings unless the limestone surface became coated with reaction products (ferric hydroxide) and the dissolution rate was substantially reduced. If this condition developed it is conceivable that the pH could decline into the preferred range for bacterial activity. In short, the potential inactivation of limestone by reaction processes in the tailings mass needs to be addressed.

Covers

Covers such as soil, sawdust, gravel, etc. have not proven to be effective in preventing pyrite oxidation or acid conditions in tailings and spoil sites (Okahara 1977, Apel 1982). Oxygen transport into the tailings pile can be reduced by the cover material. However, unless the cover is very impermeable or extremely deep, it is most unlikely that it will eliminate the transport of oxygen to a sufficient degree to prevent acid conditons from occurring.

One potentially promising concept is to apply a sufficiently deep cover to ensure that the water table rises into the cover. Because oxygen diffusion through water is much slower than through air, the overall rate of acid production could be effectively controlled to eliminate both short and long concerns. The cover material could be soil, pyrite reduced tailings or tailings with limestone added.

Covers with limestone added have been shown to prevent acid conditons in the short term (Arkesteyn 1980). The long term effectiveness of this management concept is open to question as noted in the previous discussion.

Flooding

Flooding has significant potential for reducing oxygen transport and thus controlling microbial activity and acid production in materials. Model simulations of the potential effects of flooding on the oxidation of pyrite in a tailings area gave pH predictions of about 5.7 in the oxidizing zone as compared to a pH level of 2.4 in non-flooded tailings (Halbert et al 1983). Similar results have been noted by researchers reporting on actual field investigations of exposed and flooded tailings (Hamilton et al 1978, Moffett 1980).

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

The principal conclusions which can be drawn from the assessment of the role of bacteria in the oxidation of pyritic material are summarized as follows:

1. Bacterial activity unquestionably accelerates the oxidation of pyritic material by several orders of magnitude over the chemical oxidation rate in an acid environment.

2. Although numerous species of microbes have been isolated from pyritic wastes, Thiobacillus ferrooxidans is the principal organism responsible for pyrite oxidation.

3. Microbial oxidation of pyrite and other sulphidic material has been measured over a wide range of pH values from about 1.5 to 7.0. The maximum oxidation rate occurs in a narrow pH range from about 2.0 to 4.0 which is the optimum pH regime for the growth of T. ferrooxidans. While there is no question that bacterial activity accelerates the rate of pyrite oxidation in the acid pH regime, the role that bacteria play in initiating oxidation in neutral pH media is not clear.

4. There is substantial evidence to support the contention that oxygen is the principal electron acceptor in the oxidation of sulphidic material and under most conditions the transport of oxygen to the pyrite surface is the rate limiting step. The influence of low oxygen levels on the rate of oxidation is not well defined. Also, the data suggest that pyritic material will oxidize under anoxic conditions if other suitable oxidants, such as nitrate or ferric ions, are present.

5. Increasing the gas phase carbon dioxide level from the 0.03 percent atmospheric level up to a concentration of about 0.2 to 0.5 percent has been shown to accelerate the bacterial oxidation rate. Gas phase analysis of carbon dioxide levels in uranium tailings and waste rock piles suggest that carbon dioxide is not rate limiting in situations where the solid phase contains an available carbonate source (e.g. limestone, dolomite, etc). At low carbon dioxide levels, pyrite oxidation can be uncoupled from carbon fixation and acid production continues for some time period without apparent growth.

6. Some organic inhibitors have been shown to temporarily reduce bacterial activity. However they do not provide a long term solution to the control of bacterial activity and may pose unanticipated environmental problems.

7. Inorganic metabolic inhibitors have not been proven to be effective in controlling bacterial oxidation of pyrite in natural environmental settings.

8. The mechanisms of pyrite oxidation are adequately established and described in the literature. However, none of the kinetic models currently applied to describe bacterial oxidation processes incorporate all the factors which influence the rate of bacterial activity. These factors include the pyritic reactivity, exposed pyrite surface area, pH, temperature, and oxygen concentration to name but a few.

9. The acidic conditions which develop in the oxidizing zone of pyrite uranium tailings have been found to mobilize several of the radionuclides and metals including uranium, thorium, copper, iron, lead, nickel and zinc. Precipitation of these contaminants has been observed to occur in the non-oxidizing

zone. Of the contaminants of concern, only the radium content in the tailings porewater has been seen to be largely unaffected by pH change.

10. Although several tailings materials have been identified as net acid generators, there is very little, if any, data on lead-210 or thorium-230 levels in acidic tailings porewaters.

11. The information cited in the literature supports the contention that bacterial activity results in pyrite oxidation by both direct and indirect contact mechanisms. The direct contact mechanism has significance in the long-term as bacterial attack will continue to expose further layers of pyritic material to oxidation. As a consequence a larger fraction of the pyrite in tailings materials would be subject to oxidation in any given time period.

12. The secondary mineralization (e.g. jarosite formation) which occurs as a result of bacterial activity is not sufficiently well understood, particularly with regard to the effect it has on radionuclide mobility.

13. Long term management plans for closeout of uranium tailings areas are expected to have variable effects on the rate of the microbial oxidation of pyritic materials. Of the methods reviewed, the following conclusions have been made.

    - Storage of pyritic tailings under a water cover has the greatest potential to effectively reduce pyrite oxidation such that acid generation should not present a long term problem.

    - Limestone addition to tailings for pH buffering has definite short term application but the long term effectiveness is open to question. Limestone may either leach too quickly or become inactivated by chemical deposition on the surface.

- Depyritization alone will not prevent acid production but it does show some promise as a long term management concept. In particular, there appears to be considerable merit in applying depyritized tailings as a cover material to promote flooding of the underlying tailings as the water table is raised. Any residual acidity produced in the surface zone could be managed by limestone incorporation.

- Placement of surface cover material to a depth of several feet to limit the downward diffusive transport of oxygen has questionable merit as a means of controlling pyrite oxidation. For cover material to represent an effective long term solution the water table must be raised into the cover material thus effectively flooding the tailings.

- Vegetation has proven to be effective as a method for surface stabilization at uranium tailings sites. it has not been shown to measurably reduce the rate of pyrite oxidation or acid generation.

5.2 Recommendations

Recognizing that the main objective of the National Uranium Tailings Program is to provide a scientifically credible information base on which decisions can be made, recommendations have been formulated outlining future research priorities. These are respectfully submitted below:

1. Field data on the levels of lead-210 and thorium-230 in

acidic porewater and runoff from uranium tailings need to be collected in future monitoring programs as the existing database is very sparce.

2. Future field monitoring programs at pyritic uranium tailings areas should include depth profiles of the oxygen, temperature, carbon dioxide and moisture levels in the pyrite oxidizing zone.

3. Laboratory scale studies are recommended to determine the effects of low oxygen levels on microbial oxidation kinetics. In these studies, the effect of alternative electron acceptors (ferric ion, for example) on the oxidation rate should be examined. Further research is recommended to establish the effect of carbon dioxide on the oxidation rate.

4. Laboratory scale investigations are required to better define oxygen diffusivity (the principal rate-controlling mechanism affecting pyrite oxidation) through saturated and partially saturated tailings.

5. Although not necessarily part of the NUTP mandate, a standard laboratory procedure for both conducting and reporting oxidation rate experiments is required.

6. In conjunction with the detailed field monitoring programs at specific tailings sites, concurrent laboratory scale programs should be conducted with the specific objective of developing an improved technique for translating laboratory data to field situations.

7. There is a defined need for development of a comprehensive kinetic model which takes into account those factors having an important bearing on microbial oxidation of pyritic

uranium tailings. Furthermore, an overall systems model which incorporates kinetic and transport model components needs to be verified using field data on a specific tailings area.

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REQ.NO. 23241-3-1666

CONTRACT REPORT NO. OSQ83-00229

SUPPLEMENTARY APPENDICES
ON
LITERATURE SEARCH DATABASE ABSTRACTS
FOR THE
TECHNICAL ANALYSES OF THE MECHANISMS OF
BACTERIALLY-ASSISTED PYRITE OXIDATION

DSS File No. 14SQ.23241-3-1666

Prepared by

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March 1984

414 pp

SEP 24 1984

MICROMEDIA

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APPENDIX A

NATIONAL TECHNICAL INFORMATION SERVICE (NTIS) DATABASE

SEARCH # 1 OF 4

SEARCH STRATEGY:

[ACID MINE DRAINAGE OR MINE ACID DRAINAGE]

AND

[PYRITE OR SULFIDE OR SULPHIDE]

1013861 PB83-253328
Evaluation of Acid-Mine-Water Generation and Acid-Mine-Drainage Potential of Coal and Coal-Associated Rocks
Renton, John J.
West Virginia Univ., Morgantown. Water Research Inst.
Corp. Source Codes: 015448063
Report No.: W83-03820; OWRT-A-044-WVA(1)
Aug 83 9p
Languages: English
NTIS Prices: PC A02/MF A01 Journal Announcement: GRAI8326
Country of Publication: United States
Contract No.: DI-14-34-0001-2152; A-044-WVA

Control or prevention of the drainage of acid mine water into streams is perhaps the greatest water problem in West Virginia and in the coal-mining areas of the region. After many years and much effort, the basic characteristics of the material, generally accepted as pyrite, that yields the acid is still not adequately understood. Planning, management, and control of this toxic pollutant are hindered without a sufficient understanding of the mechanisms of acid formation. This project was a small part of a continuing research effort of the principal investigator to gain a sufficient understanding of the mechanisms of mine-acid formation.

1000625 PB83-233387
Investigation of the Mechanics of Mine Acid Formation in Underground Coal Mine Drainage
(Open file rept. May 78-Jul 82)
Walsh, Fraser M.
ECO, Inc., Cambridge, MA.
Corp. Source Codes: 072517000
Sponsor: Bureau of Mines, Washington, DC.
Report No.: BUMINES-OFR-128-83
Jul 82 69p
See also PB81-179418.
Languages: English
NTIS Prices: PC A04/MF A01 Journal Announcement: GRAI8322
Country of Publication: United States
Contract No.: J0387215

The objective of this program was to determine by laboratory experiments the kinetics and mechanics of the reactions that produce acid in coal mine drainage. The program was divided into three phases: In Phase I, five coal mines, representative of Appalachian coal mines, were chosen for sampling and an experimental design was identified suited to accomplish the program objectives. In Phase II, the five mines were sampled and test protocols applied. The results showed most pyrite weathering to be based on oxidation in the presence of water. Iron bacteria, especially Thiobacillus ferrooxidans, catalyzed the rate of pyrite weathering by a factor of three. An increase in initial iron concentration in a system that modeled the mine environment acted to inhibit bacterial catalysis of weathering. In Phase III, five tailings piles were sampled and the material obtained was used to evaluate this method of bacterial catalysis inhibition. The evaluation verified method effectiveness; inhibition of over 80% of the release of weathering products was observed.

0993525 PB83-219923
Post-Mining Neutralization of Acid Surface Mine Lakes
Brugam, Richard B. ; Carlson, Mark A. ; Chakraverty, Sumitra ; Lusk, Mark
Illinois Univ. at Urbana-Champaign. Water Resources Center.
Corp. Source Codes: 034597075
Sponsor: Office of Water Resources Technology, Washington, DC.; Southern Illinois Univ., Edwardsville. Dept. of Biological Sciences.
Report No.: W83-03278; OWRT-B-138-ILL(3)
Apr 83 106p
Prepared in cooperation with Southern Illinois Univ., Edwardsville, Dept. of Biological Sciences.
Languages: English
NTIS Prices: PC A06/MF A01 Journal Announcement: GRAI8319
Country of Publication: United States
Contract No.: DI-14-34-0001-1220; OWRT-B-138-ILL

Twenty core samples and 54 surface sediment samples were taken from surface mine lakes in Missouri, Illinois, and Indiana to determine the rates of neutralization of acid mine lakes. Sediment samples were analysed for diatom microfossils, selected chemical elements, and the radionuclide, lead-210. Comparisons between lake sediment and water column chemistry indicated that neither sulfide deposition nor H2S outgasing is likely to play a major role in the neutralization process. Chemical analyses of lake sediment showed that the sediment is a sink for heavy metals. These metals are held as sulfides. There is also a considerable fraction of metal ions strongly bound to clays. This research demonstrates that acid lake neutralization is common, that it occurs over moderate time spans and that the rate is controlled by rates of acid supply from the watershed.

0983731 DE83007965
Subsurface Oxidation of Pyritic Coal-Cleaning Wastes by Chemoautotrophic Bacteria
Schubert, J. P. ; Miller, R. M.
Argonne National Lab., IL.
Corp. Source Codes: 001960000; 0448000
Sponsor: Department of Energy, Washington, DC.
Report No.: CONF-821175-1
Nov 82 19p
Symposium on surface mining hydrology, sedimentology, and reclamation, Lexington, KY, USA, 1 Nov 1982, Portions are illegible in microfiche products.
Languages: English Document Type: Conference proceeding
NTIS Prices: PC A02/MF A01 Journal Announcement: GRAI8316 ; NSA0800
Country of Publication: United States
Contract No.: W-31-109-ENG-38

The presence of the iron-oxidizing bacterium Thiobacillus ferrooxidans was investigated in groundwater and surface water at two coal refuse disposal sites in southwestern Illinois. Piezometers placed in the saturated bases of reclaimed and unreclaimed refuse piles showed high populations of the bacteria. The reclaimed pile had lower populations than did the unreclaimed coal refuse, suggesting that the reclamation effort may have caused a decline in subsurface Thiobacillus population levels. Acidic runoff water from the two piles also contained T. ferrooxidans but the levels encountered are not as high as those found in the saturated bases. Population levels of T. ferrooxidans were not high in till below the gob pile or in slurry material at the Staunton site. This may be attributed to the lower acidity and dissolved iron concentrations in groundwater at these locations, as well as to the lack of pyrite in the till and slurry material. Statistical analysis of T. ferrooxidans populations and six water quality variables for runoff and groundwater samples from the two sites showed that all seven variables were significantly intercorrelated. More samples and additional variables must be evaluated before cause/effect relationships can be determined. High populations of T. ferrooxidans were found in the saturated bases of the two refuse piles, despite low levels (< 0.5 mg/L) of dissolved oxygen. If these bacteria can catalyze pyrite oxidation under the conditions present, reduction of acid formation by refuse burial may not be successful. (ERA citation 08:019595)

0977439 PB83-180273
Biogeochemistry of Arsenic Mine Drainage
Luong, Huan V. ; Forshaug, Joan M. ; Brown, Edward J.
Alaska Univ., Fairbanks. Inst. of Water Resources.
Corp. Source Codes: 001217010
Sponsor: Office of Water Research and Technology, Washington, DC.
Report No.: W83-02290; OWRT-B-045-ALAS(1)
Nov 81 20p
Languages: English
NTIS Prices: PC A02/MF A01 Journal Announcement: GRAI8314
Country of Publication: United States
Contract No.: DI-14-34-0001-0202; OWRT-B-045-ALAS

Arsenic is enriched in gold and sulfide deposits throughout many areas of Alaska. Consequently, some stream waters, stream sediments and groundwaters contain dissolved arsenic concentrations in excess of the Environmental Protection Agency's recommended limit of 50 parts per billion (ppb: Wilson and Hawkins, 1978). We report here that the acidiophile, T. ferrooxidans is present in most neutral pH subarctic streams affected by gold mining activities. Some of these streams have measurable levels of dissolved arsenic while others do not. We also report that the presence of T. ferrooxidans increases the rate that arsenic leaches from gold-bearing material at least fourfold over the abiotic leaching rate. Whatever the mechanism of heavy metal leaching in the areas described, mining activity continues to increase. The authors feel, therefore, that studies of the biogeochemistry of these areas should continue.

953930 PB83-140616
Acid Mine Drainage: Control and Abatement Research
(Information circular/1982)
Kim, Ann G. ; Heisey, Bernice S. ; Kleinmann, Robert L. P. ; Deul, Maurice
Bureau of Mines, Pittsburgh, PA. Pittsburgh Research Center.
Corp. Source Codes: 004993027
Report No.: BUMINES-IC-8905
Oct 82 27p
Library of Congress catalog card no. 82-19724.
Languages: English
NTIS Prices: PC A03/MF A01 Journal Announcement: GRAI8307
Country of Publication: United States

Acid drainage from underground coal mines and coal refuse piles is one of the most persistent industrial pollution problems in the United States. This Bureau of Mines report reviews the acid mine drainage problem generally and describes research currently underway to combat it.

925815 PB82-227521
Reclamation of Toxic Mine Waste Utilizing Sewage Sludge Contrary Creek Demonstration Project
(Interim rept.)
Hinkle, Kenneth R.
Virginia State Water Control Board, Bridgewater.
Corp. Source Codes: 074880000
Sponsor: Industrial Environmental Research Lab., Cincinnati, OH.
Report No.: EPA-600/2-82-061
Apr 82 338p
Languages: English
NTIS Prices: PC A15/MF A01 Journal Announcement: GRAI8220
Country of Publication: United States
Contract No.: EPA-S-803801

Three abandoned pyrite mines in central Virginia that had been inactive since 1923 contained about 12 denuded ha and caused severe acid mine drainage (AMD) in a small stream known as Contrary Creek. The AMD included heavy metals and rendered the stream virtually void of aquatic life. The Virginia State Water Control Board (SWCB) was prompted to seek a solution to this problem when plans were announced in 1968 to construct a reservoir for a nuclear power plant downstream from Contrary Creek. Two of the mines comprising about 8 ha were reclaimed with an Environmental Protection Agency (EPA) demonstration grant with the SWCB contributing matching funds by in-kind services and the Soil Conservation Service providing technical assistance. Reclamation began in 1976 and included the use of sewage sludge as a soil conditioner. Severe droughts in 1976 and 1977 and the highly toxic nature of the mine wastes necessitated a continuing maintenance program to establish vegetation. By the fall of 1980 approximately 90 per cent of the reclaimed areas supported fair to good grass cover.

881671 DE81027531
Environmental Control Technology Survey of Selected US Strip Mining Sites. Volume 3. Control Technology
Bogner, J. E. ; Schubert, J. P. ; Kaszynski, G. M.
Argonne National Lab., IL.
Corp. Source Codes: 001960000; 0448000
Sponsor: Department of Energy, Washington, DC.
Report No.: ANL/EMR-2VOL.3
Feb 81 280p
Languages: English
NTIS Prices: PC A13/MF A01 Journal Announcement: GRAI8205 ; NSA0600
Country of Publication: United States
Contract No.: W-31-109-ENG-38

The environmental control technology for maintaining water quality at 21 surface mines in eastern and central US coalfields is summarized. The mines ranged from small contour-mining operations to large area mines. Seven mines used chemical reagents to neutralize acid effluents in order to conform to federal regulations. The remaining 14 mines used only settling ponds, in an effort to reduce concentrations of suspended solids. Because effluent discharges at surface coal mines do not remain in the same places over long periods of time, and because discharges are generally small (<5 gal/min) and variable, surface mine operators favor small, efficient, portable systems for applying neutralization reagents. Reagent cost is less important to surface coal mine operators than is the labor cost required for reagent application and handling. Thus, small caustic soda and soda ash treatment systems are common, even though the cost of these reagents (based on treating water of equivalent acidity) may be several times that of hydrated lime or limestone treatment. Water chemistry data indicated that the mines achieved varying degrees of success with their control technology. Costs of water treatment are expected to rise in response to enforcement of the final federal regulations for coal mine effluents; these increases will be greater in the Appalachian region than in the central United States. Surface mine operators should concentrate on pre-mining planning in order to minimize pyrite oxidation and resulting acid mine drainage. Preventing generation of poor-quality effluents, rather than maintaining treatment facilities during and after mining, could result in long-term cost savings. (ERA citation 06:029240)

948842 PB83-136010
Leachability and Revegetation of Solid Waste from Mining
(Final rept. Oct 79-Nov 81)
Apel, M. Lynn
Industrial Environmental Research Lab.-Cincinnati, OH.
Corp. Source Codes: 050490000
Report No.: EPA-600/2-82-093
Nov 82 176p
Languages: English
NTIS Prices: PC A09/MF A01 Journal Announcement: GRAI8305
Country of Publication: United States

This research study was conducted to assess the effectiveness in pollution abatement of various mining solid waste disposal strategies. Column studies were undertaken to evaluate the quality and quantity of leachate generated by the disposal of a pyrite mine waste under various soil amelioration and layering configurations and to assess the vegetative uptake of potentially hazardous materials from the solid waste. Columns containing the mine waste under one to four feet of cover soil were used to assess the capability of the cover material in reducing leachate volume, improving leachate quality, and enhancing vegetative growth. The results of this study illustrated that the quality of leachate resulting from the disposal of a pyrite mine waste may be dramatically improved by incorporating lime, sewage sludge, and fertilizer into the upper strata of the mine waste, layering sewage sludge and fertilizer on top of the lime-treated mine waste, or by covering the mine waste with a relatively heavy layer of cover soil.

943136 DE82019488
Leaching Behaviors of High-Sulfur Coal Wastes from Two Appalachian Coal-Preparation Plants
Heaton, R. C. ; Williams, J. M. ; Bertino, J. P. ; Wangen, L. E. ; Nyitray, A. M.
Los Alamos National Lab., NM.
Corp. Source Codes: 072735000; 9512470
Sponsor: Department of Energy, Washington, DC.
Report No.: LA-9356-MS
Jun 82 81p
Microfiche only after original copies are exhausted.
Languages: English
NTIS Prices: PC A05/MF A01 Journal Announcement: GRAI8303 ; NSA0700
Country of Publication: United States
Contract No.: W-7405-ENG-36

We have completed an assessment of the environmental behaviors of high-sulfur coal wastes obtained from two coal preparation plants located in northern Appalachia. Leachates obtained from these materials are often very acidic, with pH values sometimes less than 2, and contain high concentrations of a number of chemical elements. Aluminum, manganese, iron, nickel, and sometimes copper, zinc, and cadmium are released in environmentally harmful concentrations according to the Environmental Protection Agency Multimedia Environmental Goals/Minimum Acute Toxicity Effluent (MEG/MATE) system of evaluation. Iron is the worst case, with concentrations typically more than 30 times the acceptable level. In terms of leaching behavior, these wastes are very similar to the Illinois Basin coal wastes that we have studied in the past. Unless properly disposed of, these wastes may cause serious environmental degradation as a result of contaminated drainages. Studies of the chemical composition and morphology of these coal wastes reveal that many of the environmentally important elements leached from the solid wastes in high percentages (Fe, Co, Ni, Cu, Zn, As, Se) tend to reside among either mixed-layer clays or pyritic mineral phases. Elements associated with quartz or more orderly clays, such as kaolinite or illite, are generally leached in lower percentages. Important determinants of coal waste leaching behavior are pyrite, which determines the acid generating potential of the waste, calcite, which determines the capacity of the waste to self-neutralize the acids released by oxidation of pyrite, and the clay minerals, which serve as reservoirs for many of the leachable trace elements. (ERA citation 07:052596)

881405 ANL/EMR-2(V.2A)
Environmental Control Technology Survey of Selected US Strip Mining Sites. Volume 2A: Ohio: Water Quality Impacts and Overburden Chemistry of Ohio Study Site
Bogner, J. E. ; Henricks, J. D. ; Olsen, R. D. ; Schubert, J. P. ; Sobek, A. A.
Argonne National Lab., IL.
Corp. Source Codes: 001960000; 0448000
Sponsor: Department of Energy, Washington, DC.
May 79 146p
Languages: English
NTIS Prices: PC A07/MF A01 Journal Announcement: GRAI8205 ; NSA0600
Country of Publication: United States
Contract No.: W-31-109-ENG-38

An intensive study of water, overburden, and coal chemistry was conducted at a large surface mine in Ohio from May 1976 through July 1977. Sampling sites were chosen to include the final mine effluent at the outflow of a large settling pond and chemically-treated drainage from a coal storage pile. Samples were collected semimonthly and analyzed for total dissolved solids, total suspended solids, alkalinity, acidity, sulfate, chloride, and 16 metals. Field measurements included pH, flow rate, dissolved oxygen, and specific conductance. The final effluent, where sampled, generally complied with Office of Surface Mining reclamation standards for pH, iron, and total suspended solids. Comparison of the final effluent with water quality of an unnamed tributary above the mine suggested that elevated values for specific conductance, total dissolved solids, sulfate, calcium, magnesium, manganese, and zinc were attributable to the mine operation. In general, there were observable seasonal variations in flow rates that correlated positively to suspended solids concentrations and negatively to concentrations of dissolved constituents in the final effluent. Drainage from the coal storage pile contained elevated levels of acidity and dissolved metals which were not reduced significantly by the soda ash treatment. The storage pile drainage was diluted, however, by large volumes of alkaline water in the settling pond. Analysis of overburden and coal indicated that the major impact of mine drainage was pyrite oxidation and hydrolysis in the Middle Kittanning Coal and in the Lower Freeport Shale overlying the coal. However, the presence of a calcite-cemented section in the Upper Freeport Sandstone contributed substantial self-neutralizing capacity to the overburden section, resulting in generally alkaline drainage at this site. (ERA citation 05:019549)

843017 PB81-179418
Investigation of the Mechanics of Mine Acid Formation in Underground Coal Mine Drainage
(Open file rept. (Interim) May 78-Dec 79)
Walsh, Fraser
ECO, Inc., Cambridge, MA.
Corp. Source Codes: 072517000
Sponsor: Bureau of Mines, Washington, DC.
Report No.: BUMINES-OFR-22-81
Nov 80 122p
Languages: English
NTIS Prices: PC A06/MF A01 Journal Announcement: GRAI8116
Country of Publication: United States
Contract No.: [illegible]387215

This study investigates the kinetics and the mechanics of the reactions that produce acid in coal mine drainage using fresh mine face samples from five Appalachian coal mines. The results of the study show that pyrite weathering is based on oxidation in the presence of water where the oxidants can be either ferric iron or oxygen. Iron bacteria, especially T. ferrooxidans, catalyze the rate of pyrite weathering by a factor of 3. An increase in initial iron concentration in a system that models the mine environment acts to inhibit bacterial catalysis of pyrite weathering.

834205 PB81-161309
Test of Methods for Amending and Seeding Spoils at the Blackbird Mine
(Forest Service research paper)
Richardson, B. Z. ; Farmer, E. E.
Intermountain Forest and Range Experiment Station, Ogden, UT.
Corp. Source Codes: 007868000
Report No.: FSRP/INT-265
Jan 81 12p
Languages: English
NTIS Prices: PC A02/MF A01 Journal Announcement: GRAI8113
Country of Publication: United States

The report describes the acid waste drainage problem at the Blackbird copper/cobalt mine in Idaho and explains the rationale for attempting to establish vegetative cover over the mineral waste dump. It evaluates revegation treatments using organic mulches, lime, and seeding by different methods.

800371 FE-8977-T1
Investigation of Mechanics of Mine Acid Formation. Volume 1
Paciorek, K. L. ; Kimble, P. F. ; Vatasescu, A. L. ; Toben, W. A. ; Kratzer, R. H.
Ultrasystems, Inc., Irvine, CA.
Corp. Source Codes: 9502601
Sponsor: Department of Energy, Washington, DC.
Mar 80 142p
Languages: English
NTIS Prices: PC A07/MF A01 Journal Announcement: GRAI8026 ; NSA0500
Country of Publication: United States
Contract No.: ET-78-C-01-8977

The objective of the contract was to determine, by the combination of laboratory experiments and mine samplings, the kinetics and mechanisms of the various reactions that produce mine acid drainage. To achieve this goal, primary investigations were performed utilizing pure iron disulfide in the form of pyrite and marcasite, free from coal. The effects of temperature, concentration, surface area, media nature, oxygen, presence of additional ions and bacterial action with respect to dissolution rates were measured. Thiobacillus ferrooxidans and T. thiooxidans were included in this study, both as purchased cultures and freshly isolated from mine samples. Mine samplings were performed to determine the type and quantity of bacteria present, the effect of weathering upon coals' propensity to produce acid and other drainage, the effect of other minerals and the nature of the mine water upon ion liberation, and the effect of the different kinds of bacteria upon the above process. It was established that both pyrite and marcasite, provided sufficient surface area is exposed, will produce hydrogen, sulfate, and iron ions. This process is accelerated in the case of pyrite and marcasite by the presence of T. ferrooxidans and ferric ions. T. thiooxidans accelerates marcasite solubilization and the dissolution of iron disulfide present in coal, but had no effect on museum grade pyrite. (ERA citation 05:030142)

777848 LA-7831-PR
Trace Element Characterization of Coal Wastes. Third Annual Progress Report, October 1, 1977-September 30, 1978
Wewerka, E. M. ; Williams, J. M. ; Wangen, L. E. ; Bertino, J. P. ; Wanek, P. L.
Los Alamos Scientific Lab., NM.
Corp. Source Codes: 016457000; 3820000
Sponsor: Department of Energy.
Report No.: EPA-600/7-79-144
Jun 79 93p
Microfiche copies only.
Languages: English
NTIS Prices: MF A01 Journal Announcement: GRAI8018; NSA0500
Country of Publication: United States
Contract No.: W-7405-ENG-36

In 1978, we performed laboratory experiments to investigate the efficacy of several control options for treating coal wastes at the preparation plant or during disposal. Our research revealed that calcining is one of the more effective and permanent means of treating high-sulfur coal wastes before disposal to decrease, quite dramatically, the release of environmentally undesirable pollutants into the drainages from disposal sites. Another promising control method is codisposal of the coal wastes with lime or limestone to neutralize the acid drainage and retain soluble aqueous contaminants within the waste site. Other experiments have examined the feasibility of using natural sealants, such as clays, soils, calcite, and cements, to isolate the disposal site from its immediate environment. The various tradeoffs for these control options are discussed in terms of contaminant reduction, complexity, permanency, and cost. We have begun an assessment of coal preparation wastes from the Appalachian region. Based on the work we have done on refuse from a single plant, it is clear that coal wastes containing a low percentage of pyrite plant, it is clear that coal wastes containing a low percentage of pyrite (< 1 %) generate worrisome amounts of acid drainage. Our experimental results show that the trace elements of environmental concern in the leachates from these low-sulfur wastes are aluminum, manganese, iron, nickel, and copper when their concentrations are in excess of the Environmental Protection Agency's recommended Minimum Acute Toxicity Effluent (MATE) values. (ERA citation 05:009600)

771925 PB80-176357

Evaluation of Chemical Agents for Inhibiting Acid Mine Drainage Formation

(Final rept.)

Nebgen, John W. ; Weatherman, Douglas F.

Midwest Research Inst., Kansas City, MO.

Corp. Source Codes: 018262000

Sponsor: Bureau of Mines, Washington, DC.

Report No.: BUMINES-OFR-49-80

Apr 79 128p

Languages: English

NTIS Prices: PC A07/MF A01 Journal Announcement: GRAI8016

Country of Publication: United States

Contract No.: J0366036

This report contains findings from a Bureau of Mines study concerning the inhibition of acid mine drainage formation from underground coal mines. A series of experiments was performed in which three different pyritic materials (wastes from coal production plants) were evaluated using several candidate inhibiting agents. Data obtained from the inhibitor-treated pyrites were compared with data from control experiments in which untreated pyritic wastes were used. The experiments were conducted by placing treated and untreated pyrite in columns, passing moist air through the columns to promote oxidation of pyrite, and washing the columns weekly to collect oxidation products for analysis. The results indicate that quantities of acid mine drainage can be substantially reduced if soluble iron III (ferric) ion is controlled.

763896 PB80-158215

Functional Polymers for Removal of Heavy-Metal Pollutants from Water

Winston, Anthony ; Kirchner, Darrell G. ; Rosthauser, James W.

West Virginia Univ., Morgantown. Water Research Inst.

Corp. Source Codes: 015448063

Sponsor: Office of Water Research and Technology, Washington, DC.

Report No.: INFORMATION-13; WRI-WVU-80-01; W80-03911; OWRT-A-031-WVA(1)

1980 46p

Languages: English

NTIS Prices: PC A03/MF A01 Journal Announcement: GRAI8013

Country of Publication: United States

Contract No.: DI-14-34-0001-8052; OWRT-A-031-WVA

The project was to design polymeric ion-exchange resins specific for metal ions and particularly for systems for removing iron from water. The resins are vinyl polymers bearing hydroxamic acids and have strong affinity for iron. Polymers were prepared in which the spacing of the hydroxamic acids were varied. The stability constants of the iron complexes showed that the spacing of the hydroxamic acids was important both in complex stability and in the selectivity of the resin for iron. The polymer having the largest binding constant for iron had an 11-atom spacing between hydroxamic-acid groups. This polymer, prepared in an insoluble form, removed to less than 0.5 ppm iron from water. The polymer could be regenerated by washing with sodium hydrosulfite or EDTA. Copolymers bearing hydroxamic acid groups cross-link in the presence of iron, resulting in viscosity increases and flocculation. Polymers for binding copper and mercury were synthesized and evaluated. The functional group for copper was the tripeptide glycylglycylhistidine. For mercury, polymers containing sulfide were studied. Preliminary evaluation showed that the polymers formed complexes with copper and mercury. Various applications of these resins in environment, health, and industry are suggested.

761078 CONF-7905124-1

Distribution of Selected Transition and Heavy Metals in Clastic Overburden Units of the Appalachian and Interior Coal Basins: Water Quality Implications

Bogner, J. E. ; Sobek, A. A.
Argonne National Lab., IL.
Corp. Source Codes: 001960000; 0448000
Sponsor: Department of Energy.
1979 38p
International congress of carboniferour stratigraphy and geology, Urbana, IL, USA, 19 May 1979.
Languages: English Document Type: Conference proceeding
NTIS Prices: PC A03/MF A01 Journal Announcement: GRAI8013 ; NSA0600
Country of Publication: United States
Contract No.: W-31-109-ENG-38

As part of a study to investigate possible sources of transition and heavy metals transported in coal mine drainage, overburden lithologies from 18 surface mines in the Appalachian and Interior Basins were sampled and analyzed for total chemistry. The mines were widely scattered geographically so that samples could be obtained of as many representative lithologies as possible. Overburden units were predominantly Pennsylvanian basin margin clastics, with some Pennsylvanian carbonates and Pleistocene sediments in the Interior Basin. Based on lithologic descriptions, relative percentages of silicon and aluminum, and gross mineralogy from semiquantitative x-ray diffraction, the average metals concentrations for overburden units were developed for two major lithologic groups: (1) quartz-rich units, including sandstones, siltstones, and silts; and (2) clay-rich units, including shales, claystones, clays and tills. Comparing the regional averages for this study with published averages for the coals of the two regions, the highest average concentrations of most metals occurred in the fine-grained (clay-rich) units of the two regions; exceptions were chromium, strontium, and lead in Interior Basin quartz-rich units; and zinc and sulfur in Interior Basin coals. Manganese concuntrations were elevated in the quartz-rich units of both regions. In general, the Interior Basin quartz-rich units and coals contained high average concentrations of iron and sulfur; however, substantial quantities of neutralizers (reflected in high average calcium content and high neutralization potential) were also present in the Interior Basin clastics. (ERA citation 05:005325)

757740 PB8C-144793

Environmental Effects of Western Coal Surface Mining. Part IV--Chemical and Microbiological Investigations of a Surface Coal Mine Settling Pond

(Final rept.)
Turbak, Susan C. ; Olson, Gregory J. ; McFeters, Gordon A.
Colorado State Univ., Fort Collins. Natural Resource Ecology Lab.
Corp. Source Codes: 006665084
Sponsor: Environmental Research Lab.-Duluth, MN.
Report No.: EPA-600/3-79-125
Dec 79 82p
See also report dated Oct 78, PB-289 883. Prepared in cooperation with Montana State Univ., Bozeman. Dept. of Microbiology.
Languages: English
NTIS Prices: PC A05/MF A01 Journal Announcement: GRAI8011
Country of Publication: United States
Contract No.: EPA-R-803950

Chemical and microbiological investigations of the settling pond system at the West Decker Coal Mine in southeastern Montana were undertaken during 1975-1977. Concentrations of total dissolved solids, bicarbonate, sodium, sulfate, and nitrogen species in pond water were elevated in comparison to those in other nearby surface waters; however, it was concluded that these would not significantly impact the nearby Tongue River or Tongue River Reservoir. Constituents of the mine drainage waters underwent chemical changes within the pond which were at least in part due to the activities of microorganisms. The increase in pH value and in concentration of dissolved oxygen, partially attributed to photosynthesis within the pond, oxidized reduced chemical species such as sulfide and ferrous iron. The high numbers and activity measurements of sulfate reducing bacteria as well as the significant amount of metal-bound sulfides in pond sediments made a strong case for the contributions of these organisms to metal precipitation in, and possible detoxification of, pond waters.

730769 METC/RI-79/3

Kinetics and Reaction Products of Aerobic Pyrrhotite (FeS) Hydrolysis at Ambient Temperatures

Case, G. D. ; Farrior, W. L. ; Green, D. A. ; Stewart, G. W.

Department of Energy, Morgantown, WV. Morgantown Energy Technology Center.

Corp. Source Codes: 9507780

Mar 79 38p

Languages: English

NTIS Prices: PC A03/MF A01 Journal Announcement: GRAI7924 ; NSA0400

The product distributions and mechanisms of FeS hydrolysis were examined in reference to acid mine drainage, as a function of pH, NH sub 4+ ion concentration, and SO sub 2 /sulfite concentrations in aqueous suspensions. Products in the solution phase as well as precipitates and starting material residues were examined by pH and redox potentiometry, x-ray diffraction, x-ray fluorescence, scanning electron microscopy, infrared spectrometry, and wet chemical methods. Principal products of pyrrhotite hydrolysis included soluble SO sub 4 /sup =/, Fe exp 2+ , and lepidocrocite (FeOOH). In an unbuffered acid medium, equimolar leaching of iron and sulfur from FeS gives these plus some evolved H sub 2 S as the only products. Hydrolysis in unbuffered water yields the same products with the exception of H sub 2 S, with an atom ratio of Fe:S leached of 3.5 to 1. Surface pyrite (FeS sub 2), S exp O , and S-rich sulfides are not observed. Hydrolysis in ammonia at pH = 9 gives rise to equimolar FeS leaching to form Fe(OH) sub 2 , FeO(OH), and SO sub 4 /sup =/ as the only products. Hydrolysis in a bisulfite buffer (pH = 6) gives Fe exp 2+ plus lesser amounts of FeO(OH), FeO, and Fe sub 2 (SO sub 4) sub 3 . Thermodynamic and kinetic considerations, extended to present conditions, predict FeO(OH), Fe exp 2+ and SO sub 4 /sup =/ as the principal products. The kinetics of iron sulfide hydrolysis are exceedingly slow. In no case did more than 2 percent of the original FeS leach even after 6 days. (ERA citation 04:042234)

697155 PB-291 722/7

Microbial Sulfur Cycle Activity at a Western Coal Strip Mine

(Completion rept.)

Olson, Gregory J. ; McFeters, Gordon A.

Montana State Univ., Bozeman. Water Resources Research Center.

Sponsor: Office of Water Research and Technology, Washington, DC.

Report No.: MUJWRRC-98; W79-03308; OWRT-A-108-MONT(1)

Nov 78 90p

Languages: English

NTIS Prices: PC A05/MF A01 Journal Announcement: GRAI7910

Contract No.: DI-14-34-0001-8028; OWRT-A-108-MONT

Certain groups of sulfur cycle bacteria found in waters, sediments, and the coal seams of a strip mine at Decker and other mines of southeastern Montana and northeastern Wyoming were studied. Thiobacillus ferrooxidans, one of the major contributors to acid mine drainage, was consistently detected in the mining environment. Physiological studies of T. ferrooxidans isolates indicated that these acidophilic iron and sulfur oxidizing organisms were typical of the species in their preference for low pH and ability to oxidize pyrite. Hydrogen sulfide and sulfate reducing bacteria were detected in the water from all but one of the wells sampled in over a wide area in southeastern Montana. Although the activity of these organisms in the groundwater could not be demonstrated, a comparison of stable sulfur isotope ratios between groundwater sulfates and sulfides indicated the sulfide was likely produced by sulfate reducing bacteria.

689030 PB-288 946/7
Geochemistry of Mine Effluents in the Front Range Mineral Belt of Colorado
(Master's thesis)
Rojas, Armando Jose Ramirez
Colorado School of Mines, Golden.
Corp. Source Codes: 088250
Sponsor: Office of Water Research and Technology, Washington, DC.
Report No.: T-1888; W79-01363; OWRT-A-034-COLO(1)
Dec 76 120p
Languages: English Document Type: Thesis
NTIS Prices: PC A06/MF A01 Journal Announcement: GRAI7906
Contract No.: DI-14-34-0001-7012; OWRT-A-034-COLO

Results of the chemical analyses of water draining from 7 mine adits within five mining districts were compared to the ore petrology, ore mineralogy, and type of ore deposit. The water samples were collected in the Front Range Mineral Belt of Colorado in which most of the metal deposits are predominantly a complex mixture of copper, lead, zinc, and silver sulfides, gold tellurides and arsenides. The oxidation of pyrite which is associated with these complex ores yields acid water containing high concentrations of iron, sulfate and other trace metals contained in its structure. This acidity promotes the dissolution and oxidation of the other sulfides which release high concentrations of base metals to the water, but no additional acidity. The position and movement of the water table related to the ore veins and the type of ore play an important role in determining changes in the water quality from metal mine drainages. From these results, it was found that all the mine effluents fit the diffuse aquifer system. The Emmett and Clyde Mines are a good example of the type of ore vs. the water quality. In the Emmett Mine the acidity generated from the oxidation of pyrite promotes the solubility of fluorite which releases hydrofluoric acid which attacks the silicate rocks. All these reactions are responsible for the chemistry of the water found in this adit. The Clyde Mine, which shows almost complete absence of sulfide minerals, has the best water quality of all the mine effluents studied. Calculated values for redox potentials using the ferric/ferrous couple and taking into account the ionic strength activity coefficients and ferric sulfate and fluoride complexes agree very well with the measured Eh values. Conductivity was also found to correlate really well with the total dissolved solids. These results demonstrate the utility of Eh and conductance measurements in acid mine drainages.

679311 LA-7630
Trace Element Characterization of Coal Wastes. Second Annual Progress Report, October 1, 1976--September 30, 1977
Wewerka, E. M. ; Williams, J. M. ; Vanderborgh, N. E. ; Harmon, A. W. ; Wagner, P.
Los Alamos Scientific Lab., NM.
Corp. Source Codes: 3820000
Sponsor: Department of Energy.
Report No.: EPA-600/7-78-028A
Jul 78 154p
Languages: English
NTIS Prices: PC A08/MF A01 Journal Announcement: GRAI7901 ; NSA0300
Contract No.: W-7405-ENG-36

Analyses of the trace elements and major minerals in bulk refuse and coal samples from the Illinois Basin were completed. This activity was followed by studies to elucidate the structural relationships and associations among the trace elements. Several series of weathering and leaching experiments were conducted to define the environmental behavior of the trace elements in the refuse and coal samples under various environmental conditions. These investigations resulted in the identification of the trace elements of most environmental concern in typical Illinois Basin refuse and coal. Methods to control the trace element contamination of refuse and coal drainage are being investigated. These refuse materials are very complex. Some 55 elements have been identified in most of the refuse samples and undoubtedly there are more. The most abundant of these elements, iron, aluminum, and silicon, compose the structures of the major mineral systems. A large number of elements generally considered to be environmentally sensitive are present in these refuse materials in significant quantities (>30 mu g/g). Included among these are fluorine, aluminum, manganese, iron, cobalt, nickel, copper, zinc, arsenic, and lead. Although the relative amounts of some of these components are seemingly small, the absolute quantities available in a large or active waste dump could cause grave consequences in the surrounding environment if they were to be released and concentrated by natural processes. (ERA citation 03:051767)

673581 PB-284 667/3

An Evaluation of Problems Arising from Acid Mine Drainage in the Vicinity of Shasta Lake, Shasta County California

(Final rept.)

Fuller, Richard H. ; Shay, Johnevan M. ; Ferreira, Rodger F. ; Hoffman, Ray J.

Geological Survey, Menlo Park, Calif. Water Resources Div.

Corp. Source Codes: 409163

Sponsor: California Regional Water Quality Board, Sacramento. Central Valley Region.

Report No.: USGS/WRD/WRI-78/066; USGS/WRI-78-32

May 78 44p

Prepared in cooperation with California Regional Water Quality Control Board, Sacramento. Central Valley Region.

NTIS Prices: PC A03/MF A01 Journal Announcement: GRAI7824

Streams draining the mined areas of massive sulfide ore deposits in the East and West Shasta Mining Districts of northern California are generally acid and contain large concentrations of dissolved metals, including iron, copper, and zinc. The streams, including Flat, Little Backbone, Spring, West Squaw, Horse, and Town Creeks, discharge into Shasta Lake and the Sacramento River and have caused numerous fish kills. The major source of pollution is discharge from underground mines. A secondary source of pollution is streamflow and surface runoff that has passed through mine dumps where the oxidation of pyrite and other sulfide minerals results in the production of acid and the mobilization of metals. Suggested methods of treatment include the use of air and hydraulic sealing of the mines, lime neutralization of mine effluent, channeling of runoff and mine effluent away from mine and tailing areas, and the grading and sealing of mine dumps.

659412 PB-282 440/7

Assessment of Research and Development Needs and Priorities for Acid Mine Drainage Abatement

Gleason, Virginia E. ; Price, Andrea ; Boyer, Jr., James F. ; Ford, Charles T.

Bituminous Coal Research, Inc., Monroeville, Pa.

Corp. Source Codes: 058470

Report No.: BCR-L-822; BuMines-OFR-44-78

Feb 78 168p

NTIS Prices: PC A08/MF A01 Journal Announcement: GRAI7819

Contract No.: J0265044

Recommendations are made for programs to develop workable techniques to stop or to prevent acid mine drainage formation in those underground coal mines where acid production could take place. These recommendations include development of mine closure technology, development of surface water infiltration control procedures, study of the effect of roof collapse on mine water characteristics, evaluation of the long-term effects of flooding underground mines above drainage, investigation of the effectiveness of section sealing in active mines, development of a simple model for predicting mine water quality and quantity, preparation of a manual on mine drainage abatement procedures, and development of a program to disseminate information on mine drainage abatement to the coal industry. These recommendations are based on an indepth evaluation of information acquired over years of research on acid mine drainage formation, on numerous laboratory and field studies of methods of preventing or minimizing acid mine drainage formation, and on review of the geological, hydrological, and mineralogical factors involved.

658060 CONF-7710113-

Third Symposium on Coal Preparation. NCA/BCR Coal Conference and Expo IV

National Coal Association, Washington, D.C.

Corp. Source Codes: 9500412; 9500469

Sponsor: Bituminous Coal Research, Inc., Monroeville, Pa.; Department of Energy.

1977 286p

Symposium on coal preparation, Louisville, KY, USA, 18 Oct 1977.

Document Type: Conference proceeding

NTIS Prices: PC A13/MF A01 Journal Announcement: GRAI7819 ; NSA0300

The third Symposium on Coal preparation, sponsored by the National Coal Association and Bituminous Coal Research, Inc., was held at the Kentucky Fair and Exposition Center, Louisville, Kentucky, October 18-20, 1977. Fourteen papers from the proceedings have been entered individually into EDB and ERA; five additional papers had been entered previously from other sources. Topics covered involved chemical comminution and chemical desulfurization of coal (aimed at reducing sulfur sufficiently with some coals to meet air quality standards without flue gas desulfurization), coal cleaning concepts, removing coal fines and recycling wash water, comparative evaluation of coal preparation metnods, coal refuse disposal without polluting the environment, spoil bank reprocessing, noise control in coal preparation plants, etc. (ERA citation 03:034467)

658059 CONF-7710112-
Seventh Symposium on Coal Mine Drainage Research. NCA/BCR Coal Conference and Expo IV
National Coal Association, Washington, D.C.
Corp. Source Codes: 9500412; 9500469
Sponsor: Bituminous Coal Research, Inc., Monroeville, Pa.: Department of Energy.
1977 264p
Symposium on coal mine drainage research, Louisville, KY, USA, 18 Oct 1977.
Document Type: Conference proceeding
NTIS Prices: PC A12/MF A01 Journal Announcement: GRAI7819 ; NSA0300

The Seventh Symposium on Coal Mine Drainage Research, sponsored by the National Coal Association and Bituminous Coal Research, Inc., was held at the Kentucky Fair and Exposition Center, Louisville, Kentucky, October 18-20, 1977. Seventeen papers from the proceedings have been entered individually into EDB and ERA. Topics covered include chemical reactions of pyrite oxidation and acid formation in spoil banks, abandoned mines, etc., formation of small acid lakes from the drainage and their neutralization by natural and other neutralization measures, trace elements in acid mine drainage, ground water contamination, limnology, effects of surface mined ground reclamation and neutralization, water purification and treatment, mining and coal preparation plant waste disposal, ash and fly ash disposal (to minimize leaching from the wastes), runoff from large coal storage stockpiles during storms (prevention of environmental effects by collection and neutralization by passing through an ash pond). (ERA citation 03:034410)

653209 ORNL/TM-6186
Review of the Literature on Leachates from Coal Storage Piles
Davis, E. C. ; Boegly, Jr, W. J.
Vanderbilt Univ., Nashville, Tenn.
Corp. Source Codes: 6660000; 4832000
Sponsor: Oak Ridge National Lab., Tenn.; Department of Energy.
Jan 78 45p
NTIS Prices: PC A03/MF A01 Journal Announcement: GRAI7817 ; NSA0300
Contract No.: W-7405-ENG-26

Runoff from coal storage piles associated with coal conversion or combustion facilities may represent a potential source of environmental pollution. This report is an assessment of existing information on coal pile leachate. The assessment indicates that few detailed studies have been conducted to date, and these are limited and the results are highly variable. More detailed long-range studies using various types of coal are recommended. These studies should be carried out both in the laboratory and in field-scale experiments. (ERA citation 03:030170)

650653 PB-280 180/1
Site Selection and Design for Minimizing Pollution from Underground Coal Mining Operations
(Final rept. Jun 74-Dec 76)
Shotts, Reynold Q. ; Sterett, Eric ; Simpson, Thomas A.
Alabama Univ., University. Coll. of Engineering.
Sponsor: Industrial Environmental Research Lab., Cincinnati, Ohio.
Report No.: EPA/600/7-78/006
Jan 78 111p
NTIS Prices: PC A06/MF A01 Journal Announcement: GRAI7816
Contract No.: EPA-68-03-2015

The objectives of this study were to determine how best to select a layout and mining system and also to develop and operate an underground coal mine while at the same time minimizing pollution of the environment. The pre-mining environment was assessed by sampling Cedar Creek 3 and other streams. Analyses of samples of groundwater into the mine, of the water pumped from the mine sump, and of water from Cedar Creek below the mine, made possible the assessment of the area with regard to water quality. Principal factors associated with mining which affected downstream water quality were sulfide oxidation and acid formation in the mine, the quality of the groundwater seeping into the mine, the limestone used for rock dusting, and the quality of the resettled but not treated mine and washing plant water carried to the continuous miners for dust suppression. Deep mines in Alabama's synclinal coalfields, if entered some distance from the outcrop, or mined down-dip if started on the outcrop, should produce little surface pollution.

633484 PB-277 089/9
Mine Drainage Control from Metal Mines in a Subalpine Environment - A Feasibility Study
(Final rept. Jun 73-Aug 77)
Montana Dept. of Natural Resources and Conservation, Helena. Engineering Bureau.
Sponsor: Industrial Environmental Research Lab., Cincinnati, Ohio.
Report No.: EPA/600/2-77/224
Nov 77 181p
NTIS Prices: PC A09/MF A01 Journal Announcement: GRAI7810
Contract No.: EPA-S-802671

Investigations of the McLaren mine and mill areas and the Glengary mine area in the vicinity of Cooke City, Montana, were undertaken from July 1973 through September 1975, to examine the acid mine drainage (AMD) from these sources and determine the feasibility of rehabilitating these subalpine mining areas and mill area. A biological study was conducted to determine the existing degraded biological conditions of streams affected by AMD and the extent of reclamation necessary to restore a viable fishery to the stream. Reclamation proposed includes recontouring and revegetating land surfaces, sealing shafts in the mine area, and isolating the tailings from Soda Butte Creek.

627437 CONF-770862-1
Microbial Ecology of Coal Mine Refuse
Cameron, R. E. ; Miller, R. M.
Argonne National Lab., Ill.
Corp. Source Codes: 0448000
Sponsor: Energy Research and Development Administration.
1977 61p
International symposium on microbial ecology, Dunedin, New Zealand, 22 Aug 1977.
Document Type: Conference proceeding
NTIS Prices: PC A04/MF A01 Journal Announcement: GRAI7808 ; NSA0300
Contract No.: W-31-109-ENG-38

Baseline microbial and ecological studies of samples obtained from two abandoned coal mine refuse sites in the State of Illinois indicate that the unfavorable nature of refuse materials can be a very limiting factor for survival and growth of organisms. Despite the ''foothold'' obtained by some microorganisms, especially acidophilic fungi and some acidotolerant algae, the refuse materials should be amended or ameliorated to raise the pH, provide needed nutrients, especially nitrogen, and provide biodegradable organic matter, both for physical and biological purposes. Finally, the role of microbial populations, responses, and interactions in acid mine wastes must be put into larger perspective. Acid mine drainage amounts to over 4 million tons per year of acidity from active and abandoned mines. Microorganisms appear to be significantly responsible for this problem, but they also can play a beneficial and significant role in the amelioration or alleviation of this detrimental effect as abandoned mines are reclaimed and returned to useful productivity. (ERA citation 03:007886)

623417 LA-UR-77-1850
Environmental Pollution by Trace Elements in Coal Preparation Wastes
Williams, J. M. ; Wewerka, E. M. ; Vanderborgh, N. E. ; Wagner, P. ; Wanek, P. L.
Los Alamos Scientific Lab., N.Mex.
Corp. Source Codes: 3820000
Sponsor: Energy Research and Development Administration.
Report No.: CONF-771024-1
1977 11p
NCA/BCR coal conference, Louisville, Kentucky, USA, 19 Oct 1977.
Document Type: Conference proceeding
NTIS Prices: PC A02/MF A01 Journal Announcement: GRAI7806 ; NSA0300
Contract No.: W-7405-ENG-36

Coal preparation waste contains a multitude of leachable elements. Data for 18 elements are presented here. Generally these elements occur in the waste leachates at levels related to their occurrence in the water. Closer inspection reveals, however, that some elements are much more leachable than others. Thus, for Illinois-Basin waste iron is found to be present in waste leachate in high amounts, but this amount represents only a small percentage of the total iron in the waste. Cobalt and nickel, on the other hand, are not very plentiful in the waste, but are highly leachable. Aluminum, a major constituent of clays in the waste, is very poorly leached. Oxygen availability is a prime factor in the production of soluble iron which is readily flushed from the waste. Particle size is less important. Under damp conditions and with plenty of air, pyrite oxidizes rapidly. This latter situation poses a problem for the plant operator, as coal preparation wastes are discarded damp and remain so via rainstorms for long periods before they are covered. (ERA citation 03:002165)

599599 PB-270 090/5

Paleoenvironment of Coal and Its Relation to Drainage Quality

(Final rept. 1 Aug 73-31 Jul 75)

Caruccio, Frank T. ; Ferm, John C. ; Horne, John ; Geidel, Gwendelyn ; Baganz, Bruce

South Carolina Univ., Columbia. Dept. of Geology.

Sponsor: Industrial Environmental Research Lab., Cincinnati, Ohio.

Report No.: EPA/600/7-77/067

Jun 77 121p

NTIS Prices: PC A06/MF A01 Journal Announcement: GRAI7722

Contract No.: EPA-R-802597-02

The acid production potential of a coal was related to its paleoenvironment (environment of deposition) as interpreted from the overlying strata. Within the Appalachian coal field of eastern Kentucky, coals and associated strata were characterized as either back-barrier, lower delta plain or upper delta plain. Samples from various paleoenvironments were analyzed for sulfur content and pyrite types (reactive versus stable). Samples from the back-barrier, lower delta plain sequence had a relatively higher percentage of reactive pyrite than the seams within strata of upper delta plain. Both environments produced coals of similar total sulfur contents and both contained varying percentages of framboidal pyrite. Although reactive pyrite was present in seams of both paleoenvironments, a differing natural water chemistry caused acid mine drainage to be associated with the back-barrier, lower delta plain strata and never with the upper delta plain strata. This study showed that the pyrite distribution and, more importantly, the water chemistry producing acidic or neutral drainages, were correlative with the paleoenvironment of the coals and associated strata.

591906 PB-268 444/7

Hydrogeology of the Formation and Neutralization of Acid Waters Draining from Underground Coal Mines of Western Maryland

Hollyday, E. F. ; McKenzie, S. W.

Maryland Geological Survey, Baltimore.

Report No.: REPT. OF INVESTIGATIONS-20

1973 66p

NTIS Prices: PC A04/MF A01 Journal Announcement: GRAI7719

The flows from 18 underground mines for which mine maps are available in the bituminous coal basins of western Maryland were measured, and water samples were collected for determination of 27 major dissolved constituents and chemical properties and 28 minor elements. Natural neutralization is taking place in the underground environment and the most nearly neutralized acid mine drainage is associated with flow from an upper mine to a lower mine through the intervening rock strata.

587780 PB-267 561/9

Heavy Metal Discharges into Shasta Lake and Keswick Reservoirs on the Upper Sacramento River, California: A Reconnaissance During Low Flow

(Water-resources investigations (Final))

Nordstrom, D. Kirk ; Jenne, Everett A. ; Averett, Robert C.

Geological Survey, Menlo Park, Calif. Water Resources Div.

Corp. Source Codes: 409163

Report No.: USGS/WRD/WRI-77/030; USGS/WRI-76-49

Mar 77 33p

NTIS Prices: PC A03/MF A01 Journal Announcement: GRAI7717

Four out of seventeen streams entering the Shasta-Keswick Reservoir system contribute up to 94 percent of the heavy metal load into the upper Sacramento River under the low flow conditions which existed in the fall of 1974. Of these four streamn, three contain acid mine drainage, with Spring Creek carrying more than 50 percent of the total load for every element analyzed except lead. The Pit River, the fourth stream, contains low concentrations of metals and neutral pH values, but since it carries the highest discharge, its computed loads also are high. The immediate danger to fish in thw Shasta - Keswick region is not the contribution of acidity and toxic metals to the total load, but the localized point of mixing where the acid streams mix with lake water. Zinc and cadmium, in addition to copper, are present in high concentrations for five of the seventeen streams and may exert significant synergistic effects. The presence of arsenic in some of the ore minerals suggests that it also may contribute to the toxicity of the mine drainage.

554642 PB-262 579/6

Surface Mine Water Quality Control in the Eastern Kentucky Coal Fields

(Final rept.)

Kimball, L. Robert

Kentucky Dept. for Natural Resources and Environmental Protection, Frankfort.

Sponsor: Appalachian Regional Commission, Washington, D.C.

Report No.: ARC-71-66/T5-F

Mar 74 216p

See also PB-262 578. Errata sheet inserted.

NTIS Prices: PC A10/MF A01 Journal Announcement: GRAI7707

This report and accompanying field manual offers the Commonwealth of Kentucky a means to aid in the control of chemical stream pollution resulting from surface mining. It attacks the source of the problem, chemical contaminants contained within the overlying strata associated with the coal seam. The study, designed and primarily aimed at the pre-mining identification of potential chemical pollution characteristics, will serve to strengthen state programs directed toward protecting Kentucky's streams and rivers.

461226 COM-75-11073/4
Environmental Management and Regional Economic Development
(Research rept.)
Miernyk, William H.
West Virginia Univ., Morgantown. Regional Research Inst.
Sponsor: Economic Development Administration, Washington, D.C. Office of Economic Research.
Report No.: EDA/OER-75-020
6 Nov 71 24p
Presented to the Southern Economic Association and the Southern Regional Science Association, Miami Beach, Fla. 6 Nov 71.
NTIS Prices: PC A02/MF A01 Journal Announcement: GRAI7520
Contract No.: EDA-OER-411-G-72-9

A preliminary report is made on a long-range investigation of the trade-offs between environmental management and regional economic development. The analytical tool is a dynamic regional input-output model. The full study, which will take into account all types of pollution, is being conducted in a series of discrete phases. The first phase deals with the special case of surface coal mining. Phase two is concerned with the abatement of air pollution. In this phase of the study, a regional variant of Leontief's augmented input-output model of the static-open variety with built in pollution-related activities, is being used. For this purpose, regional pollution output coefficients will be grafted onto the West Virginia dynamic regional model.

389084 PB-230 965/6
Solution to Problems of Pollution Associated with Mining in Northern Idaho
(Open file rept.)
Ralston, Dale R. ; Trexler, Jr., Bryson D. ; Wai, Chien M. ; Renison, William R. ; Rickman, Jr, Francis E.
Idaho Bureau of Mines and Geology, Moscow.
Report No.: BuMines-OFR-13-74
1 Dec 73 109p
NTIS Prices: PC A06/MF A01 Journal Announcement: GRAI7412
Contract No.: H0122070

This report describes the results of a two-phase investigation to identify sources and causes of mine water pollution in Northern Idaho. The first phase effort examined the occurrence and production of acid water at the Bunker Hill Mine, using a water monitoring network that extended throughout the mine. The report shows low pH water was formed in those mine areas containing lead-zinc ore rich in pyrite and that water movement in the mine was important both in the production of acid and also in tranportation of heavy metals. The second phase evaluated water movement characteristics in an abandoned tailings pile and the resultant impact on the hydrologic environment. Initial data indicated (1) existence of a ground water mound under the pond and (2) transfer of ions from the tailings pile to the surrounding groundwater system. The report is of special interest to the mining industry of the Coeur d'Alene District of Idaho and of general interest to persons concerned about pollution associated with mining.

380958 PB-228 584/9
Removal of Heavy Metals from Mine Drainage by Precipitation
(Environmental protection technology series)
Rose, Laurence W.
Denver Univ., Colo. Dept. of Chemical Engineering and Metallurgy.
Report No.: W74-04851; EPA-670/2-73-080
Sep 73 71p
Paper copy available from GPO $1.00 as stock no. EP1.23:670/2-73-080.
NTIS Prices: PC-GPO/MF A01-NTIS Journal Announcement: GRAI7409
Contract No.: EPA-14040-FZC

Heavy metals in mine drainage waters of the Rocky Mountains can be removed by a two-stage process consisting of (1) neutralization followed by (2) sulfide treatment. The first stage removes ferric and aluminum hydroxides, and the second (sulfide) stage precipitates the heavy metals that are most objectionable as pollutants, and that are of possible interest for economic recovery. The two-stage process has been demonstrated in the laboratory and in a field experiment. (Modified author abstract)

332657 PB-219 264/9
Organic Wastes as a Means of Accelerating Recovery of Acid Strip-Mine Lakes
(Completion rept., 1 Jul 70-30 Jun 72)
King, Darrell L. ; Simmler, Joseph J.
Missouri Water Resources Research Center, Columbia.
Report No.: W73-07808; OWRR-A-038-MO(1)
20 Feb 73 70p
NTIS Prices: PC A04/MF A01 Journal Announcement: GRAI7313
Contract No.: DI-14-31-0001-3225; DI-14-31-0001-3525; OWRR-A-038-MO

The study determines the role of metals in the natural and accelerated recovery of strip-mine waters from the time of acid formation on the pyrite crystal to the time of lake recovery. A host of acid dissociated ionic species, including iron, sulfate, hydrogen, aluminum, manganese, calcium, and magnesium, and allochthonous organic materials characterize the chemistry of these lakes. The metal buffers are responsible for the long natural recovery times associated with all acid strip-mine lakes. The amount of such buffers depends upon the amount and type of clays and minerals dissolved on the spoil banks. The recovery rate of such lakes is dependent on the availability of carbon sources for sulfate reducing bacteria to use as food while they 'titrate' the acidity by releasing H2S to the atmosphere until all buffers are exhausted.

329665 PB-214 876
Sulfide to Sulfate Reaction Mechanism. A Study of the Sulfide to Sulfate Reaction Mechanism as It Related to the Formation of Acid Mine Waters
Smith, E. E. ; Shumate, K. S.
Ohio State Univ. Research Foundation, Columbus.
Corp. Source Codes: 267360
Feb 70 129p
Prepared in cooperation with Federal Water Pollution Control Administration.
Paper copy available from GPO $1.50 as stock no. EP2.10:14010 FPS-02/70.
NTIS Prices: PC-GPO/MF A01-NTIS Journal Announcement: D7301
Contract No.: FWPCA-14010-FPS

A detail study of the mechanisms and kinetics of the chemical reactions responsible for acid mine drainage is discussed. The mineralogical features of the solid phase reactant (pyrite) that determine its reactivity were described. The rate-limiting reactions and variables affecting the rate of these reactions were identified. It was found that two basic oxidation modes are important: oxygenation, in which oxygen is the immediate oxidizing agent; and ferric ion (or microbiologically catalyzed) oxidation, in which ferric ions are the oxidants. From a knowledge of the dissolved oxygen, ferric/ferrous ratio, and total iron ion content at the reaction site, the reaction regime can be determined. Kinetic equations were derived for both reaction modes. From these basic relationships the oxidation rate in real pyritic systems can be accurately predicated when conditions at the reaction site are known. (Author)

316752 PB-214 771/8
Pilot Scale Study of Acid Mine Drainage
Ohio State Univ. Research Foundation, Columbus.
Corp. Source Codes: 267360
Report No.: W73-05216; EPA-WQO-14010-EXA-03/71
Mar 71 85p
Paper copy available from GPO $1.00 as EP1.16:14010EXA03/71.
NTIS Prices: PC-GPO/MF A01-NTIS Journal Announcement: GRAI7307
Contract No.: DI-14-12-97; EPA-WQO-14010-EXA

In order to study pyrite oxidation and resulting acid mine drainage, a research facility was developed using a small, long-abandoned drift mine and six 33 inch diameter auger holes drilled in order to have comparable, isolated, experimental 'mines' on a pilot scale basis. Experimental data and observations of the effect of oxygen concentration on acid production have shown the location of major reaction zones and indicated that bacterial catalysis of pyrite oxidation is not a significant factor in production of acid mine drainage. When the correspondence between holes has been established, one hole will be used as a reference mine so that fluctuations due to hydrologic variations can be separated from effects of experimentally imposed changes in the other holes.

310364 PB-213 887/7

Pyritic Systems: A Mathematical Model

North, Arthur H. ; Smith, Edwin E. ; Shumate, Kenesaw S.

Ohio State Univ. Research Foundation, Columbus.

Corp. Source Codes: 267360

Report No.: EPA-R3-72-002; W73-03508

Nov 72 169p

Paper copy available from GPO $2.25 as EP1.23/2:72-002.

NTIS Prices: PC-GPO/MF A01-NTIS Journal Announcement: GRAI7304

Contract No.: EPA-14-12-589; EPA-14010-EAH

A mathematical model of an acid mine drainage system has been developed for underground mines. The model relates the rate of acid formation to the rate of pollution discharge from the system. The calculational model was developed using a digital computer to simulate an existing mine as the sum of many micro scale mines. The input to the model is a physical and chemical description of the system. Day-to-day simulation requires data on temperature, rainfall, and oxygen concentration at the exposed coal face. The output of the model is estimates of daily acid load and drainage flow. The calculational model was based on a carefully described physical model so that a predictive model can be constructed with little or no experimental data. However, methods for constructing the computational model are given which can use the field data available to increase the reliability.

310207 PB-213 720/8

Neutradesulfating Treatment Process for Acid Mine Drainage

Catalytic, Inc., Philadelphia, Pa.

Report No.: EPA-WQO-14010-DYH-12/71

Dec 71 116p

Paper copy available from GPO $1.00 as EP1.16: 14010DYH 12/71.

NTIS Prices: PC-GPO/MF A01-NTIS Journal Announcement: GRAI7304

Contract No.: EPA-14-12-818; EPA-WQO-14010-DYH

A process has been developed for treatment and removal of major pollutants in surface streams of Appalachia caused by acid mine drainage. The raw water is neutralized with sodium bicarbonate to precipitate iron and aluminum, followed by cation exchange to remove sulfate. Barium is eluted from the exchange resin and reacts with sulfate in the water to form a precipitate. Barium is recovered from the precipitate and is processed to recharge the exchange resin. The water is further treated to remove hydrogen sulfide by conversion to sulfur as a saleable byproduct. The process minimizes the cost of sludge and waste disposal while offering a product water meeting the highest interstate water quality standards. Treatment costs are given. (Author)

302211 PB-213 008/0

Inorganic Sulfur Oxidation by Iron-Oxidizing Bacteria

(Water pollution control research series)

Lundgren, Donald G.

Syracuse Univ., N.Y. Dept. of Biology.

Report No.: W73-01609; EPA-14010-DAY-06/71

Jun 71 166p

Paper copy available from GPO $1.25 as EP2.10:14010DAY06/71.

NTIS Prices: PC-GPO/MF A01-NTIS Journal Announcement: GRAI7301

Contract No.: EPA-14010-DAY

Sulfur metabolism of Thiobacillus ferrooxidans and rhodanese-sulfite oxidase enzymes were studied. As disclosed by electron microscope examination, the purified cell envelope of lipopolysaccharide contains a very high quantity of ferric iron. A new colorimetric whole cell assay was developed to study iron oxidation. The presence of pyrophosphatase enzyme was revealed for the first time in chemolithotrophic microorganisms. Study of energy soruces disclosed that the chemolithtrophic T. ferrooxidans can evolve heterotrophic mechanisms and grow on glucose, following the Entner-Doudoroff pathway. (Author)

288806 PB-206 231

Microbiological Treatment of Acid Mine Drainage Waters

(Water pollution control research series)

Continental Oil Co., Ponca City, Okla. Research and Development Dept.

Report No.: W72-04100; EPA-WQO-14010-ENW-09/71

Sep 71 85p

Paper copy available from GPO $1.00 as EP2.10:14010 ENW 09/71.

NTIS Prices: PC-GPO/MF A01-NTIS Journal Announcement: GRAI7207

Contract No.: EPA-WQO-14010-ENW

The purpose of the study was to determine if the abilities of certain bacteria to oxidize ferrous iron or to convert sulfate to hydrogen sulfide could be applied to the neutralization and subsequent removal of iron from difficult-to-treat mine drainage waters. If one or both of these concepts could be successfully utilized, the expense of adequately treating these types of problem waters might be significantly reduced. Laboratory studies demonstrated that both pure cultures and fresh field cultures of acidophilic iron bacteria could readily oxidize ferrous iron in both synthetic and natural acid mine drainage waters. Approximate requirements of oxygen, carbon dioxide, nitrogen and phosphorus by the iron bacteria were established. Limestone neutralizations of partially oxidized acid mine waters were conducted. Although sulfate-reducing bacteria were isolated, attempts to grow the cultures or produce hydrogen sulfide at pH values below 5.5 were unsuccessful.

244584 PB-203 679
The Effects of Various Gas Atmospheres on the Oxidation of Coal Mine Pyrites
(Water pollution control series)
Robins, John D. ; Troy, Joseph C.
NUS Corp., Pittsburgh, Pa. Cyrus Wm. Rice Div.
Report No.: W72-00081; EPA-WQO-14010-ECC-08/71
Aug 71 148p
Paper copy available from GPO $1.25 as stock no. 5501-0111.
NTIS Prices: PC-GPO/MF A01-NTIS Journal Announcement: GRAI7124
Contract No.: FWPCA-14-12-877; EPA-WQO-14010-ECC

Experiments up to 180 days in length were conducted to study the acid production rate of coal mine pyrites under various gas atmospheres. The gas atmospheres studied were air, nitrogen, methane, and carbon dioxide. The lower limits of the oxidation process were studied by introducing small amounts of oxygen along with the inert blanketing gas and by studying the effects of deaerated versus air saturated feedwater. Acid production was proportional to the available oxygen partial pressure. The acid parameters monitored continued to change and had not completely reached a steady state by the termination of the work. The acid production of nitrogen blanketed pyrite decreased to less than 1% of that of identical columns under air atmosphere. Nitrogen and methane gases were equally effective in reducing acid production. Both of these gases were slightly more effective than carbon dioxide. A large amount of detailed experimental data is presented. (Author)

242681 PB-203 488
Study of Sulfur Recovery from Coal Refuse
(Water pollution control research series)
LaRosa, Paul J. ; Michaels, H. James
Black, Sivalls and Bryson, Inc., Pittsburgh, Pa. Applied Technology Div.
Report No.: W71-13895; EPA-WQO-14010-FYY-09/71
Sep 71 65p
Paper copy available from GPO $0.70 as stock no. 5501-0137.
NTIS Prices: PC-GPO/MF A01-NTIS Journal Announcement: GRAI7123
Contract No.: EPA-14-12-929; EPA-WQO-14010-FYY

During coal preparation, a coal refuse of no commercial value is produced and discarded in piles. As rainfall percolates through the piles, acid waters are formed. A feasibility study has been performed on a process producing sulfur from such coal refuse. In this process, limestone and coal refuse are ground, pelletized, and preheated before entering a desulfurizing shaft reactor where a hard, fired ash pellet and an H2S-SO2 bearing offgas are produced. After sulfur, tar, and other gases are removed, the resulting H2S-SO2 gas proceeds to a conventional sulfur recovery plant. Experimental results and economics of this study indicate that the process is a profitable means of minimizing coal refuse pile water pollution. For a sulfur and ash pellet selling price of $20 and $1.50/ton respectively, it is estimated that a coal producer will have a before tax return on investment up to 53 percent for a one MM ton/year plant utilizing an eight percent sulfur refuse. (Author)

225603 PB-199 835
Acid Mine Drainage Formation and Abatement
(Water Pollution Control Research series)
Ohio State Univ. Research Foundation, Columbus.
Report No.: EPA-DAST-42; W71-08591; EPA-14010-FPR-04/71
Apr 71 89p
NTIS Prices: PC A05 MF A01 Journal Announcement: GRAI7115
Contract No.: EPA-14010-FPR

The report pertains to at-source control of pyrite oxidation. The current level of knowledge of acid mine drainage formation is critically reviewed, with emphasis on reaction kinetics and reactant and product transport. A reaction system model is developed which provides a conceptual framework for subsequent discussion dealing specifically with the physical, chemical, and biological characteristics of pyritic systems encountered in mining situations. Practical considerations of at-source control of acid mine drainage formation in underground mines, spoil banks, and refuse piles are presented. Deficiencies in current knowledge include: Descriptions of the physical environment existing at pyrite oxidation sites in natural systems are far more incomplete that the current understanding of pyrite oxidation kinetics; Oxygen transport is poorly described at this time, but is probably the rate-controlling factor in most instances; Serious questions exist as to the effectiveness of air-sealing techniques as currently practiced; The significance of bacterial catalysis of pyrite oxidation under field conditions has not been established. (Author)

219023 PB-198 523
Evaluation of Pyritic Oxidation by Nuclear Methods
(Research rept.)
Baker, Robert A.
Carnegie-Mellon Univ., Pittsburgh, Pa.
Corp. Source Codes: 403586
Report No.: W71-07137; EPA-WQO-14010-F11-03/71
Mar 71 39p
Paper copy available from SOD $0.50 as EP 2.10:14010F1103/71.
NTIS Prices: PC-SOD/MF A01-NTIS Journal Announcement: GRAI7112
Contract No.: FWPCA-14010-FII; EPA-WQO-14010-FII

Laboratory studies demonstrated the feasibility of using the Mossbauer effect and a backscattering mode of detecting 14.4 Kev gamma rays to spectroscopically monitor the oxidation processes taking place on pyrite materials. A cobaltous oxide form of cobalt-57 was the radiation source. Spectra were obtained of pyritic surfaces under 2 mm of water. Differentiation of nonoxidized and oxidized pyritic surfaces was possible with further separation of the spectra to show individual oxidation product peaks suggesting ferric hydroxide and ferric sulfate. (Author)

201164 PB-196 113
Microbiological Factor in Acid Mine Drainage Formation. II. Further Observations from a Pilot Plant Study
(Water pollution control research series)
Baker, Robert A. ; Wilshire, Albert G.
Mellon Inst., Pittsburgh, Pa.
Corp. Source Codes: 225300
Report No.: W71-02278; FWQA-14010-DKN-11/70
Jul 70 81p
Paper copy available from Superintendent of Documents, GPO, Washington, D.C. 20402. $0.70 as I67.13/4:14010-DKN-11/70.
NTIS Prices: PC SOD MF A01 Journal Announcement: USGRDR7103
Contract No.: FWQA-14010-DKN

The role of chemoautotrophic organisms in the formation of acid mine drainage from pyritic materials associated with coal mining has been investigated by pilot plant techniques. Dynamic flow, controlled environment units which served as models of mines were used. It was demonstrated that the concentration of acidity, ferrous and total iron and sulfate in the effluent from aerobic, biologically-seeded or unseeded pyritic beds is zero order with respect to flow, except at low flow rates where mass transport is diffusion limited. Algal growth occurred in thw acidic, aerobic environment but did not affect acid production. Nonaerobic systems produce acidity consisting only of ferrous iron. Total acidity is lower from biologically-seeded than -nonseeded aerobic systems. Acid mine drainage was not significantly affected by seeding with the individual or a mixture of three different organisms but was increased by recycle of the flow and increased appreciably under forced aeration. The rate is directly related to the available pyrite surface area. (WRSIC abstract)

B

APPENDIX B

National Technical Information Service (NTIS) Database

Search #2 of 4

Search Strategy:

[Acid Mine Drainage or Mine Acid Drainage or Mine Waste(s) or Mine Water(s)]

AND

[Pyrit? or Sulphide or Sulfide or Iron or Tailings]

NOT

[Search #1]

1022467 PB84-111681

Evaluation of Metals and Other Substances Released Into Coal Mine Accrual Waters on the Wasatch Plateau Coal Field, Utah

(Water quality series rept.)

Seierstad, A. J. ; Adams, V. D. ; Lamarra, V. A. ; Hoefs, N. J. ; Hinchee, R. E.

Utah Water Research Lab., Logan.

Corp. Source Codes: 016805000

Sponsor: Office of Water Research and Technology, Washington, DC.

Report No.: UWRL/Q-83/09; W84-00028; OWRT-B-210-UTAH(2)

Aug 83 170p

Languages: English

NTIS Prices: PC A08/MF A01 Journal Announcement: GRAI8402

Country of Publication: United States

Contract No.: DI-14-34-0001-1273; OWRT-B-210-UTAH

The objectives of this research were to: Determine the chemical nature of coal mine accrual waters discharged from the Wasatch Plateau coal field by sampling waters collected within and discharged from subsurface coal mines on the Plateau for a period of one year; Predict the effects; Evaluate compliance of the minewater discharges with NPDES regulations.

1017080 PB84-101245

Comparative Limnology and Biota of Mine Spoils Ponds in Colorado (Journal Version)

(Journal reprint)

Canton, S. P.

Colorado State Univ., Fort Collins.

Corp. Source Codes: 006665000

Sponsor: Environmental Research Lab.-Duluth, MN.

Report No.: EPA-600/J-82-390

1982 13p

Pub. in the Southwestern Naturalist 27(1), p33-42 1982.

Languages: English Document Type: Journal article

NTIS Prices: PC A02/MF A01 Journal Announcement: GRAI8401

Country of Publication: United States

Contract No.: EPA-R-803950

Physico-chemical and biotic parameters were investigated from June 1977 to May 1978 in coal strip-mine ponds in Colorado which differed in age and in the proportion of drainage derived from the mine. There were no discernible effects of mine drainage on temperature, dissolved oxygen, hardness, pH, acidity, alkalinity, calcium, iron, orthophosphate, or the organic content of the substrate. Total dissolved solids, nitrate, and sulfate values were higher in the spoils ponds than in the control pond. Net zooplankton abundance was lowest in the youngest spoils pond, but the standing crop of benthos exhibited a progressive decrease from the youngest spoils pond to the control pond.

1010647 DE83014211

Environmental-Control-Technology Survey of Selected US Strip-Mining Sites: Water-Quality Impacts and Overburden Chemistry of Tennessee Study Sites

Henning, R. J. ; Henricks, J. D. ; Bogner, J. E. ; Sobek, A. A. ; Vinikour, W. S.

Argonne National Lab., IL.

Corp. Source Codes: 001960000; 0448000

Sponsor: Department of Energy, Washington, DC.

Report No.: ANL/EES-TM-218

Dec 82 158p

Languages: English

NTIS Prices: PC A08/MF A01 Journal Announcement: GRAI8325 ; NSA0800

Country of Publication: United States

Contract No.: W-31-109-ENG-38

As part of a program to examine the ability of existing control technologies to meet federal guidelines for the quality of aqueous effluents from coal mines, an intensive study of water quality was conducted at two surface coal mines in Tennessee during 1976 and 1977. In general, water quality in receiving streams below each mine is poor due to previous mining and inherent conditions such as poor substrate, low-volume discharges, and naturally low pH. Effluents from both mines appear to contribute acidic water that contains dissolved, potentially toxic metals. At Mine TN-1, treatment of acid drainage by diversion through limestone-riprapped channels and an automatic NaOH feeder did not appear effective in controlling pH, iron, and manganese. Sedimentation ponds at TN-2 do not appear effective in controlling pH, iron, and manganese. However, total suspended solids appear to be adequately controlled by sedimentation ponds at both sites. There is a general lack of neutralizers in the overburden sequence. Overburden from the weathered zone should be segregated and subsequently replaced on the surface after reclamation. The remaining overburden is potentially acid-toxic and should be mixed with limestone and returned to the pit on a layer of crushed limestone. Efforts should be made to limit infiltration into spoils. Water control should be exercised in order to minimize infiltration of oxygen-bearing water into the mine-soil; this will reduce formation of acid seeps at the base of the spoil. At both sites, mining would not significantly increase the magnitude of downstream flooding. Increased impact on the receiving stream. (ERA citation 08:040027)

0993647 PB83-807297
Acid Mine Drainage. October 1978-May 1983 (Citations from the NTIS Data Base)
National Technical Information Service, Springfield, VA.
Corp. Source Codes: 055665000
Jun 83 115p
Supersedes PB82-807009 and PB81-801649.
Languages: English Document Type: Bibliography
NTIS Prices: PC N01/MF N01 Journal Announcement: GRAI8319
Country of Publication: United States

The bibliography on acid mine drainage cites studies primarily concerning control and treatment methods. Reports on hydrogeology, ecology, formation, and sources are included. (This updated bibliography contains 108 citations, 29 of which are new entries to the previous edition.)

0990583 PB83-208306
Metabolic Properties of 'Thiobacillus ferrooxidans' Isolated from Neutral pH Mine Drainage
(Completion rept.)
Brown, Edward J. ; Forshaug, Joan M.
Alaska Univ., Fairbanks. Inst. of Water Resources.
Corp. Source Codes: 001217010
Sponsor: Office of Water Research and Technology, Washington, DC.
Report No.: COMPLETION-81-11; W83-03045; OWRT-A-070-ALAS(1)
Mar 83 53p
Languages: English
NTIS Prices: PC A04/MF A01 Journal Announcement: GRAI8318
Country of Publication: United States
Contract No.: DI-14-34-0001-2101; OWRT-A-070-ALAS

Thiobacillus ferrooxidans is found in heavy-metal contaminated drainages from placer and lode gold mines in many parts of Alaska and Canada. We have examined the iron-limited growth kinetics of a T. ferrooxidans isolate, AK1, using continuous cultures. AK1 is an arsenic tolerant isolate obtained from placer gold mine drainage containing large amounts of dissolved arsenic. The steady state growth kinetics can be described by a simple Monod equation modified for threshold ferrous iron concentrations. Kinetic descriptions of the iron-limited growth of acidophilic iron-oxidizing bacteria are important for understanding the biogeochemical cycling of many metals and for application of these microorganisms to biohydrometallurgy.

0980400 PB83-191437
Pilot Plant Treatment of Acid Mine Drainage by Reverse Osmosis
(Final rept. 21 May 73-15 Sep 75)
Blackshaw, G. Lansing ; Pappano, Alfred W. ; Thomas, Jr., Garth E. ; Cheng, Shun-Yung
West Virginia Univ., Morgantown. Dept. of Chemical Engineering.
Corp. Source Codes: 015448047
Sponsor: Industrial Environmental Research Lab.-Cincinnati, OH.
Report No.: EPA-600/2-83-031
Apr 83 138p
Languages: English
NTIS Prices: PC A07/MF A01 Journal Announcement: GRAI8315
Country of Publication: United States
Contract No.: EPA-68-03-0245

Studies were conducted at the EPA Crown Mine Drainage Control Field Site (a) to examine the performance of a 227,000 lpd (60,000 gpd) reverse osmosis (RO) unit at recovery levels of 50 percent through 90 percent for a variety of dominantly ferrous iron acid mine drainage (AMD) feed qualities, (b) to evaluate the feasibility of using the neutrolosis process to treat AMD, and (c) to determine the AMD treatment capability of a coupled 18.9 lpm (5 gpm) sodium cycle cation exchange (CIX)/RO system.

0969773 PB83-170688

Contamination of Ground and Surface Waters by Uranium Mining and Milling. Volume II. Field Sampling and Empirical Modeling

(Open file rept. (Final) 25 Jul 79-14 Sep 81)
Markos, Gergely ; Bush, Kathryn J.
Colorado Univ. at Denver.
Corp. Source Codes: 068648000
Sponsor: Bureau of Mines, Washington, DC.
Report No.: BUMINES-OFR-19-83
Dec 81 129p
Also pub. as GEC Research, Inc., Rapid City, SD. rept. no. GECR/R-818. See also Volume 1, PB82-251992.
Languages: English
NTIS Prices: PC A07/MF A01 Journal Announcement: GRAI8312
Country of Publication: United States
Contract No.: J0295033

Uranium mill tailings represent a potential threat to the human habitat by containing large amounts of radioactive and chemically toxic substances in high concentrations. These undesired components enter the human habitat in various pathways such as by erosion and water or air transport. The main objective of this investigation was to evaluate the actual movement and model the potential movement of contaminants by seepage of water from the tailings into the subtailings soil. This report represents various models of the movement of contaminants using both theoretical approaches and empirical evaluation of data available from other investigations. Data analysis shows that the critical area of investigating movements is the interfaces between tailings and the external environment. The chemical differences at interfaces seem to result in a sink system for contaminants. The tailings-soil-water system shows extreme complexities because of chemical and physical heterogeneity of the system preventing the use of a single comprehensive model to represent real conditions. The validity of the simplifying assumption used has been shown and increasing complexity has been built into the models. Analogs of these models can be used for evaluation of similar systems.

964079 PB83-150029

Evaluation of the Effectiveness of Hydrogen and Oxygen Isotopes Used in Concert with Chemical Water-Quality Parameters as Indicators of Subsurface Water Movement and Source

Thurnblad, Timothy W.
Arizona Univ., Tucson. Dept. of Hydrology and Water Resources.
Corp. Source Codes: 000951078
Sponsor: Office of Water Research and Technology, Washington, DC.
Report No.: W83-01633; OWRT-A-103-ARIZ(1)
Sep 82 143p
Portions of this document are not fully legible.
Languages: English
NTIS Prices: PC A07/MF A01 Journal Announcement: GRAI8310
Country of Publication: United States
Contract No.: OWRT-A-103-ARIZ

A multiuse area, 15 miles south of Tucson, Arizona, was selected to test a water-pollution source assessment technique emphasizing the combined study of stable isotopes of water, major anions and cations, trace elements, pH, specific conductance, and water temperature. Computer-based analytical techniques were developed to identify data patterns indicating effects of recharge sources. The range in isotopic ratios along the study transect suggested that tracing surface-water recharge by its isotopic signature is possible, if density and frequency of sampling are sufficient. At some sites, water quality parameters were found to exceed state drinking-water supply standards. High sulfate concentrations were found in the surface water of mine pits and tailings ponds.

953890 PB83-140020

Influence of Particle Size Distribution on Water Quality in Agricultural Impoundments

Ghosh, Mriganka M. ; Lochmoeller, Todd
Missouri Univ.-Columbia. Dept. of Civil Engineering.
Corp. Source Codes: 049959038
Sponsor: Office of Water Research and Technology, Washington, DC.
Report No.: W83-01280; OWRT-A-132-MO(1)
30 Sep 82 195p
Languages: English
NTIS Prices: PC A09/MF A01 Journal Announcement: GRAI8307
Country of Publication: United States
Contract No.: DI-14-34-0001-2127; OWRT-A-132-MO

In recent years, the development of electric particle counters has created opportunities for more sensitive measurement of liquid-solid associations than has been possible previously. Very few particle size distribution (PSD) measurements have been made for natural systems. This research investigates the changes in PSD in a reservoir following storm events and the role PSD plays in transporting lead introduced into a river system by a mine tailings spill. The reservoir chosen for study is an agricultural flood retarding reservoir in central Missouri.

951301 PB83-137810
Biological Oxidation of Iron (II) by T. Ferrooxidans in a Sequencing Batch Reactor
(Rept. for May 80-Aug 82)
Theis, T. L. ; Ketchum, Jr., L. H. ; Irvine, R. L .
Notre Dame Univ., IN. Dept. of Civil Engineering.
Corp. Source Codes: 020618023
Sponsor: Bureau of Mines, Washington, DC.
Report No.: BUMINES-OFR-185-82
Aug 82 142p
Languages: English
NTIS Prices: PC A07/MF A01 Journal Announcement: GRAI8306
Country of Publication: United States
Contract No.: J0100079

The use of a suspended growth system of T. ferrooxidans attached in a film to individual particles of bentonite and operated as a sequencing batch reactor has proved to be a practical way of oxidixing ferrous iron in acid mine drainage. This component, followed by limestone neutralization, is both a technically and economically feasible approach to the treatment of these wastewaters in comparison with existing and proposed methods. The advantages, in addition to less expense, are greater safety, acceptable treatment at a lower pH, lower solids buildup, less danger of overtreatment and greater flexibility in operational characteristics. In this reort, data on the continuous bench-scale operation of the system under a variety of conditions shows sustained levels of oxidation in excess of 95 pct.

941702 PB83-111369
Heavy Metals Pollution of the Upper Arkansas River, Colorado, and Its Effects on the Distribution of the Aquatic Macrofauna
Roline, Richard A. ; Boehmke, John R.
Bureau of Reclamation, Denver, CO. Engineering and Research Center.
Corp. Source Codes: 005117032
Report No.: REC-ERC-81-15
Sep 81 80p
Languages: English
NTIS Prices: PC A05/MF A01 Journal Announcement: GRAI8302
Country of Publication: United States

A limnology study was done on a 30 km section of the upper Arkansas River, Colorado, to determine the effects of heavy metals pollution on the distribution of the aquatic macrofauna. Physical and chemical water parameters were measured, aquatic macroinvertebrates were collected, and fish populations at selected stations were evaluated to determine density and heavy metal content of tissue. Historically, river flows which dilute heavy metal concentrations were not as high as those occurring since transmountain diversions began. However, water quality, species diversity of aquatic macroinvertebrates, fish populations, and metal accumulation in fish tissue show that heavy metal pollution of the upper Arkansas River near Leadville, Colorado, is presently very severe. Heavy-metal-laden inflows adversely affect water quality and thus the aquatic animal populations, while freshening inflows improve water quality and, therefore, conditions for the aquatic fauna.

939886 PB83-108621
The Laurel Run Acid Mine Drainage Renovation Demonstration Facility: An Evaluation
Sharpe, William E. ; Vanagel, Mark A. ; Sherwin, Lysle S
Pennsylvania State Univ., University Park. Inst. for Research on Land and Water Resources.
Corp. Source Codes: 009222081
Sponsor: Office of Water Research and Technology, Washington, DC.
Report No.: W83-00258; OWRT-A-057-PA(1)
Apr 82 70p
Languages: English
NTIS Prices: PC A04/MF A01 Journal Announcement: GRAI8301
Country of Publication: United States
Contract No.: DI-14-34-0001-1140; OWRT-A-057-PA

An acid mine drainage treatment demonstration facility was constructed to treat discharges from a small drift coal mine. Acid drainage was stored in a small impoundment, and used to irrigate a limed 0.23 hectare natural hardwood forest plot at 11.4 cm/week. Appreciable iron and sulfate removed and a decrease in specific conductance occurred in the storage pond. Gravity flow irrigation of the plot further improved mine discharge water quality, but pH improvement was minimal and sulfate and aluminum levels remained high in shallow groundwater samples taken. The success of this demonstration facility was limited by the acidic poorly-drained soils used for irrigation. Plot tree mortality increased during the demonstration study.

936766 PB82-260415
Waste Products in Missouri with Potential Highway Application
(Missouri cooperative highway research program (Final))
Missouri Highway and Transportation Dept., Jefferson City. Div. of Materials and Research.
Corp. Source Codes: 073267001
Sponsor: Federal Highway Administration, Washington, DC.
Report No.: MCHRP-81-2; FHWA/RD-82-P0007
Apr 82 70p
Languages: English
NTIS Prices: PC A04/MF A01 Journal Announcement: GRAI8226
Country of Publication: United States

A statewide survey to locate solid waste products having potential for highway applications was conducted during 1981. The survey inventory includes 305 separate entries representing some 80 million tons of waste material currently accumulating at an annual rate of about 5 million tons. Due to the State being a prime source of metal ore mining and smeltering, vast tonnages of mine tailings have accumulated. Also, considerable tonnages of electric utility waste products continue to accumulate in the form of fly ash, dry bottom boiler ash, and wet bottom boiler slag. Possible uses for each waste material product are cited. From the summarized inventory, certain waste products were selected that appear to warrant further evaluation.

930503 PB82-200494
Pilot Scale On-Site Evaluation of Activated Carbon for Rapid Oxidation of Ferrous Iron in Acid Mine Water
(Open file rept. 24 Sep 79-5 Jun 81)
Perrotti, Anthony E. ; Snyder, Alvin J.
Rhode Island Analytical Labs., Inc., Warwick.
Corp. Source Codes: 075554000
Sponsor: Bureau of Mines, Washington, DC.
Report No.: BUMINES-OFR-58-82
Oct 81 70p
Languages: English
NTIS Prices: PC A04/MF A01 Journal Announcement: GRAI8218
Country of Publication: United States
Contract No.: J0395036

A pilot plant for evaluating rapid oxidation of ferrous iron under acidic conditions was designed, fabricated, and operated at a typical mine site for 6 months. The effect of activated carbon as a catalyst on the oxidation reaction was tested using three fluidized carbon bed reactors in series. Test runs for iron oxidation were made at various pH levels with and without the presence of activated carbon. Runs were extended to evaluate the changes in oxidation rate in relation to carbon life. Results of the study indicated that initial enhancement of the oxidation of ferrous iron was not sustained. The increased removal of ferrous iron concentration was found to be due to adsorption by the carbon rather than due to catalysis.

925851 PB82-809278
Uranium Mining and Milling Environmental Studies. 1970-April, 1982 (Citations from the Engineering Index Data Base)
National Technical Information Service, Springfield, VA.
Corp. Source Codes: 055665000
Jun 82 205p
Supersedes PB81-804932, and PB80-805450.
Languages: English Document Type: Bibliography
NTIS Prices: PC N01/MF N01 Journal Announcement: GRAI8220
Country of Publication: United States

Worldwide research is cited on uranium mining waste management and effluent control. Studies on mining practices, radon monitoring, health hazards, and land reclamation are covered. Government policies and regulations concerning present and long term waste handling are included. (This updated bibliography contains 198 citations, 58 of which are new entries to the previous edition.)

925360 PB82-213901
Abandoned Mine Reclamation: A Case Study at Live Oak, Florida
(Open file rept. 1 Apr 79-15 May 8)
Herbert, T. A. ; Turner, R. G.
Center for Resource Development, Tallahassee, FL.
Corp. Source Codes: 075585000
Sponsor: Bureau of Mines, Washington, DC.
Report No.: BUMINES-OFR-75-82
30 May 81 115p
Languages: English
NTIS Prices: PC A06/MF A01 Journal Announcement: GRAI8220
Country of Publication: United States
Contract No.: J0295007

A 2,338-acre mine site near Live Oak, Fla., was studied to determine the potential for reclamation and development. Present land uses of the area surrounding the abandoned mine were analyzed along with locations of abandoned cuts, spoil piles and tailings, and land ownership patterns. An economic analysis of the surrounding five-county area was conducted to determine what types of industries might relocate at the mine site. Methods commonly used to reclaim abandoned mines were discussed along with possible interim and end land uses; financial incentives available from the Federal, State, and local sources were discussed.

922272 PB82-223918
Failure of Dam No. 3 on [illegible] Middle Fork of Buffalo Creek Near Saunders, West Virginia [illegible] February 26, 1972
Seals, Roger K. ; Marr, J[illegible] Allen ; Lambe, T. William
National Research Council, [illegible]ton, DC.
Corp. Source Codes: 019026[illegible]
Sponsor: National Science [illegible], Washington, DC.
1972 35p
Languages: English
NTIS Prices: PC A03/MF A01 [illegible] Announcement: GRAI8221
Country of Publication: Uni[illegible]
Contract No.: NSF-C310-TO-115[illegible]

At approximately 8 a.m. on Saturday, February 26, 1972, a coal refuse dam located near the mouth of the Middle Fork of Buffalo Creek at Saunders, West Virginia, failed. The failure released approximately 176 million gallons of water into the Buffalo Creek Valley. Prior to entering Buffalo Creek, the water broke through two other dams. The flood waters flowed along Buffalo Creek Valley to Man, West Virginia, where they entered the Guyandotte River. In the three hours it took to traverse the 17-mile length of the Buffalo Creek Valley, the flood produced damage estimated to be between 30 and 50 million dollars. In addition, the flood caused 118 deaths, left approximately 4,000 homeless, and destroyed or seriously damaged approximately 850 permanent and mobile homes. Also destroyed were approximately 1,000 cars and trucks, several highway and railway bridges, sections of railroad tracks and highways, and portions of utility facilities. The Office of Emergency Preparedness estimated the cost of the flood to the 17 participating federal agencies to be approximately $22 million, which included $7 million in disaster relief and $12 million in funds for road reconstruction. This report summarizes the observations, findings, and recommendations of an inspection team.

918509 PB82-244302
Partial Listing of Coal Waste Embankments, Surface and Underground Openings: Appendix, Volume II
(Open file rept. (Final) Mar 80-Aug 81)
Ahnell, G. ; Hervol, J. D. ; Mentz, J. W. ; McClure, R. E. ; Reed, T. L.
Skelly and Loy, Harrisburg, PA.
Corp. Source Codes: 058545000
Sponsor: Bureau of Mines, Washington, DC.
Report No.: BUMINES-OFR-100(3)-82
Feb 82 233p
See also Volume 1, PB82-244294.
Also available in set of 3 reports PC E99, PB82-244278.
Languages: English
NTIS Prices: PC A11/MF A01 Journal Announcement: GRAI8222
Country of Publication: United States
Contract No.: J0205001

Volume 3 of this three-volume report contains brief descriptions of the terms and codes used for each of the inventoried sites in Mining Safety and Health Administration districts 3, 4, 5, and 6. Detailed site mapping and the disposal site characterization forms for districts 5 and 6 are included.

918508 PB82-244294
Partial Listing of Coal Waste Embankments, Surface and Underground Openings: Appendix, Volume I
(Open file rept. (Final) Mar 80-Aug 81)
Ahnell, G. ; Hervol, J. D. ; Mentz, J. W. ; McClure, R. E. ; Reed, T. L.
Skelly and Loy, Harrisburg, PA.
Corp. Source Codes: 058545000
Sponsor: Bureau of Mines, Washington, DC.
Report No.: BUMINES-OFR-100(2)-82
Feb 82 246p
See also PB82-244286, and Volume 2, PB82-244302.
Also available in set of 3 reports PC E99, PB82-244278.
Languages: English
NTIS Prices: PC A11/MF A01 Journal Announcement: GRAI8222
Country of Publication: United States
Contract No.: J0205001

Volume 2 of this three-volume report contains brief descriptions of the terms and codes used for each of the inventoried sites in Mining Safety and Health Administration districts 3, 4, 5, and 6. Detailed site mapping and the disposal site characterization forms for districts 3 and 4 are included.

918507 PB82-244286
Partial Listing of Coal Waste Embankments, Surface and Underground Openings
(Open file rept. (Final) Mar 80-Aug 81)
Ahnell, G. ; Harvel, J. D. ; Mentz, J. W. ; McClure, R. E. ; Reed, T. L.
Skelly and Loy, Harrisburg, PA.
Corp. Source Codes: 068545000
Sponsor: Bureau of Mines, Washington, DC.
Report No.: BUMINES-OFR-100(1)-82
Feb 82 131p
See also Volume 1, PB82-244294.
Also available in set of 3 reports PC E99, PB82-244278.
Languages: English
NTIS Prices: PC A07/MF A01 Journal Announcement: GRAI8222
Country of Publication: United States
Contract No.: J0205001

Throughout portions of four heavily mined Appalachian States subdivided by the Mine Safety and Health Administration as: district 3, northern West Virginia and Maryland; district 4, southern West Virginia; district 5, Virginia; and district 6, eastern Kentucky, active coal mine waste embankments associated with mechanical and/or chemical coal processing facilities of various levels of coal preparation were inventoried. For each site plant specifications, disposal techniques, embankment characteristics, and coal source data were accumulated. Mapping at 1:24,000 and 1:250,000 scale and disposal site characterization forms were developed to present the findings.

914315 DE82006862
Evaluation of the Effect of Coal Cleaning on Fugitive Elements. Final Report: Phase II. Part III. State-of-the-Art: Fate of Trace Elements in Coal During Mining, Preparation, and Utilization
Boyer, J. F. ; Costantino, J. P. ; Ford, C. T. ; Gleason, V. E. ; Rosnick, K. A.
Bituminous Coal Research, Inc., Monroeville, PA.
Corp. Source Codes: 004145000; 9500469
Sponsor: Department of Energy, Washington, DC.
Report No.: DOE/EV/04427-53; COO-4427-53
Jul 81 272p
Languages: English
NTIS Prices: PC A12/MF A01 Journal Announcement: GRAI8223 ; NSA0000
Country of Publication: United States
Contract No.: AC22-77EV04427

Cleaning is particularly effective in removing those trace elements not associated with the organic fraction of the coal. Elements which often have a high organic association include germanium, beryllium, gallium, titanium, boron, and vanadium. Problem elements that are significantly removed by cleaning include arsenic, chromium, cobalt, copper, fluorine, lead, manganese, mercury, nickel, vanadium, and zinc. The principal release of trace elements to the environment during cleaning is in the drainage from refuse-disposal sites. During coal combustion for power generation, the trace elements present in coal are incorporated into the bottom ash, fly ash, or the flue gas. The degree of partitioning varies with the physical and chemical properties of the element, the type and operating conditions of the combustion unit, etc. In general, mercury, chlorine, bromine, and fluorine are discharged as vapors. Aluminum, barium, calcium, cesium, cobalt, iron, mercury, potassium, lanthanum, magnesium, manganese, rubidium, scandium, silicon, samarium, tantalum, thorium, and thallium show little preferential partitioning between slag or fly ash. Arsenic, cadmium, copper, gallium, molybdenum, lead, antimony, selenium, and zinc are more concentrated in fly ash. The atmospheric emissions of trace elements resulting from coal combustion are limited to those elements which leave the stack as vapors and those incorporated into that fly ash which is not collected by particulate control devices.

910764 PB82-807652
Coal Mine Waste. 1964-March, 1982 (Citations from the NTIS Data Base)
National Technical Information Service, Springfield, VA.
Corp. Source Codes: 055665000
Apr 82 259p
Supersedes PB81-801110, and PB80-804404.
Languages: English Document Type: Bibliography
NTIS Prices: PC N01/MF N01 Journal Announcement: GRAI8216
Country of Publication: United States

Research topics cover coal mining refuse, refuse dumps, and spoil. Studies on disposal, utilization, environmental impacts, and testing of these wastes are included, as are reports on land reclamation and spoil bank safety. (This updated bibliography contains 282 citations, 38 of which are new entries to the previous edition.)

910348 PB82-138812
Land Utilization and Reclamation in the Mining Industry, 1930-80
(Information circular/1982)
Johnson, Wilton ; Paone, James
Bureau of Mines, Washington, DC.
Corp. Source Codes: 004978000
Report No.: BUMINES-8862
Feb 82 28p
Library of Congress catalog card no. 81-38489.
Languages: English
NTIS Prices: PC A03/MF A01 Journal Announcement: GRAI8216
Country of Publication: United States

The Bureau of Mines study indicates that land utilized by the mining industry for mineral extraction and processing from 1930 through 1980 amounted to 5.7 million acres, or 0.25 percent of the land mass in the United States. Land reclaimed by the industry during the same period was 2.7 million acres, or 47 percent of the land utilized. Land use by the mining industry includes surface land used for excavation or mining, for waste from underground mining, and for wastes from milling or processing operations. Data on land use for disposal of overburden waste from surface coal mines and on areas affected by subsidence associated with underground mining are included in the report for the period 1930-71 only.

910209 PB82-193251
A Study of Environmental Factors Affecting Acid Mine Drainage Treatment with Rotating Biological Contractors: Phase II
(Final rept.)
Unz, Richard F. ; Wichlacz, Paul L.
Pennsylvania State Univ., University Park.
Corp. Source Codes: 009222000
Sponsor: Appalachian Regional Commission, Washington, DC.
Report No.: ARC-79-197-7134
Mar 82 103p
Languages: English Document Type: Conference proceeding
NTIS Prices: PC A06/MF A01 Journal Announcement: GRAI8216
Country of Publication: United States
Contract No.: ARC-79-197-CO-7134-79-I-302-0829

Interaction of metal sulfides, oxygen, water, and the biochemical faculties of iron-oxidizing, chemolithotrophic bacteria provide for the generation of acid and mineral-bearing wastes during coal and metal ore excavation. Extensive investigations have been conducted on the micro-biological transformation of ferrous iron with application to the partial treatment of acidic, coal mine drainage. It has been established that the rotating biological contactor (RBC), conventionally employed in treatment of organic wastewaters, is capable of achieving ferrous iron oxidation efficiencies in excess of 90 percent while sustaining a resilient population of chemolithotrophs over a wide range of temperature, pH, and mass ferrous iron loadings. Performance of the system is not adversely affected by sudden alterations of abiotic variables over the range typical of the natural environment. The microbial composition of the mine drainage environment has been explored and found to consist of diverse acidophilic, chemo-organotrophic bacteria in addition to the chemolithotrophs. Interrelationships which may exist between the two microbial groups need to be identified against the possibility that combined heterotrophic-autotrophic activities are the major biological force in the generation of acidic mine drainage.

905557 PB82-807009
Acid Mine Drainage. October, 1978-February, 1982 (Citations from the NTIS Data Base)
National Technical Information Service, Springfield, VA.
Corp. Source Codes: 055665000
Apr 82 84p
Supersedes PB81-801649, and PB80-801475.
Languages: English Document Type: Bibliography
NTIS Prices: PC N01/MF N01 Journal Announcement: GRAI8214
Country of Publication: United States

The bibliography on acid mine drainage cites studies primarily concerning control and treatment methods. Reports on hydrogeology, ecology, formation, and sources are included. (This updated bibliography contains 79 citations, 23 of which are new entries to the previous edition.)

889520 PB82-139304
Control of Water Pollution from Surface Mining Operations: Volume I
(Open file rept. 1 Oct 79-30 Sep 80)
Jessey, David R. ; Stengl, Judith M. ; Dike, David H. ; Brown, Grant R. ; Schroeder, Edward S.
WAPORA, Inc., Chevy Chase, MD.
Corp. Source Codes: 072086000
Sponsor: Bureau of Mines, Washington, DC.
Report No.: BUMINES-OFR-161(1)-81
31 Jan 81 172p
See also Volume 2, PB82-139312. Prepared in cooperation with Ketron, Inc., Wayne, PA.
Languages: English
NTIS Prices: PC A08/MF A01 Journal Announcement: GRAI8208
Country of Publication: United States
Contract No.: J0199089

Water pollution problems associated with surface metal-nonmetal mines throughout the United States were assessed. Three major problems were identified: acid mine drainage, toxic concentrations of heavy metals, and excessive sedimentation. Among the factors that affect the type and amount of pollutants generated at mine sites are hydrologic regime, geology, mineralogy, topography, climate, size of the mineralized area, and mining methods. Nine surface mines situated in different settings were visited and the pollution problems were studied in the report.

871081 DE81027532
Environmental Control Technology Survey of Selected US Strip Mining Sites. Volume 4. Evaluation of Effluent Guidelines for the Coal Mining Industry
Henning, R. J. ; Vocke, R. W.
Argonne National Lab., IL.
Corp. Source Codes: 001960000; 0448000
Sponsor: Department of Energy, Washington, DC.
Report No.: ANL/EMR-2VOL.4
Feb 81 182p
Languages: English
NTIS Prices: PC A09/MF A01 Journal Announcement: GRAI8201 ; NSA0600
Country of Publication: United States
Contract No.: W-31-109-ENG-38

An evaluation is made of the effectiveness of the federal Office of Surface mining coal mine wastewater effluent limitations as they relate to the Surface Mining control and Reclamation Act of 1977 (P.L. 95-87). The act was formulated to protect society and the environment from the adverse effects of surface coal mining operations; it also requires that an adequate coal supply be ensured to meet the nation's energy requirements. To achieve these objectives, an examination of preceding state and federal guidelines is required. At 21 study sites, it was found that compliance with state regulations was generally achieved more often than compliance to the promulgated EPA guidelines. Non-compliance was a result of many hard-to-quantify factors including: dynamic hydrologic conditions, changing mine locations through time, noncontinuous manual treatment strategies, and economic considerations. Changes in the values of water quality variables in the mining environment can be a result of geological and hydrological constraints, as well as inherent random error. This suggests that the promulgation of rigid guideline values that can be exceeded is not the best approach. Rather, statistical methods that recognize sufficiently long recurrence intervals can be used to describe natural conditions more accurately. The variables regulated by the EPA (iron, manganese, total suspended solids, and pH) are not the most toxic commonly present and controllable. Iron and manganese, especially, are present in overburden and are not limiting variables with regard to water quality. Concentrations of toxic trace elements in mine drainage are localized and are related to overburden/coal geochemistry. (ERA citation 06:029252)

848982 PB81-185431
Water Quality in an Idaho Stream Degraded by Acid Mines Waters
(General technical rept.)
Platts, William S. ; Martin, Susan B. ; Primbs, Edward R. J.
Intermount&in Forest and Range Experiment Station, Ogden, UT.
Corp. Source Codes: 007868000
Report No.: FSGTR/INT-67
1980 29p
Languages: English
NTIS Prices: PC A03/MF A01 Journal Announcement: GRAI8117
Country of Publication: United States

The report discusses studies made from 1967 through 1977 that show seepage from the no longer operating Blackbird Mine in east central Idaho has resulted in acidic waters high in sediment and heavy metals. It suggests high concentrations of cobalt, copper, iron, manganese, lead, and zinc in the Panther Creek drainage are the probable cause of diminished insect and fish populations in the area.

843368 PB81-804932
Uranium Mining and Milling Environmental Studies. 1970-February, 1981 (Citations from the Engineering Index Data Base)
(Rept. for 1970-Feb 81)
National Technical Information Service, Springfield, VA.
Corp. Source Codes: 055665000
Mar 81 147p
Supersedes PB80-806450, and NTIS/PS-79/0140.
Languages: English Document Type: Bibliography
NTIS Prices: PC N01/MF N01 Journal Announcement: GRAI8116
Country of Publication: United States

Worldwide research is cited on uranium mining waste management and effluent control. Studies on mining practices, radon monitoring, health hazards, and land reclamation are covered. Government policies and regulations concerning present and long term waste handling are included. (This updated bibliography contains 140 citations, 30 of which are new entries to the previous edition.)

839669 PB81-172645
Limestone-Lime Treatment of Acid Mine Drainage - Full Scale
(Final rept. Oct 68-Oct 77)
McDonald, David G. ; Grandt, Alten F.
Peabody Coal Co., St. Louis, MO.
Corp. Source Codes: 027605000
Sponsor: Industrial Environmental Research Lab., Cincinnati, OH.
Report No.: EPA-600/7-81-033
Mar 81 206p
Languages: English
NTIS Prices: PC A10/MF A01 Journal Announcement: GRAI8115
Country of Publication: United States
Contract No.: EPA-14010-DAX

The nation-wide problems related to acidic discharges from coal mining operations are well documented in both popular and technical literature. Neutralization is and will continue to be a necessary short-term measure in numerous instances, while long-range programs are being developed to prevent and/or arrest acid production at the source. Considerable effort has been expended in investigating the neutralization of acid mine drainage with limestone, lime, and soda ash. A combination limestone-lime process has been shown to have cost advantages with improved effluent quality and sludge settling characteristics. This document is the final and summary report on the neutralization studies. Utilizing a full scale neutralization plant, the effect of detention time, sludge recirculation, flow pattern, and treatment pH have been observed using limestone and lime separately and in combination. Data have been accumulated on highly acidic ferric iron acid mine drainage to determine the most economical method of treatment. Plant operation indicates that combination limestone-lime treatment with sludge recirculation on both treatment lines is the most economical scheme of treatment.

839411 DOE/EV/10154-T1
Conceptual Design of a Regional Water Quality Screening Model
Davis, M. J.
Argonne National Lab., IL.
Corp. Source Codes: 001960000; 0448000
Sponsor: Department of Energy, Washington, DC.
Jan 81 56p
Languages: English
NTIS Prices: PC A04/MF A01 Journal Announcement: GRAI8115 ; NSA0600
Country of Publication: United States
Contract No.: AC02-80EV10154

This water quality assessment methodology is intended to predict concentrations at future times and to estimate the impacts on water quality of energy-related activities (including industrial boilers). Estimates of impacts on water quality at future times are based on incremental changes in pollutant inputs to the body water. Important features of the model are: use of measured concentrations to account for existing conditions; consideration of incremental changes in pollutant loads; emphasis on the energy sector and industrial boilers; analysis restricted to streams only; no attempt to fully account for pollutant behavior; and flexible design, so that future improvements can be incorporated. The basic approach is very similar to the one used by Argonne's AROUAL model but will allow more complex pollutant behavior and more flexibility in use. (ERA citation 06:009671)

834226 PB81-161564
Acid Mine Waste Revegetation: Influence on Soil-Water Quality
(Forest Service research paper)
Farmer, Eugene E. ; Richardson, Bland Z.
Intermountain Forest and Range Experiment Station, Ogden, UT.
Corp. Source Codes: 007868000
Report No.: FSRP/INT-266
Jan 81 14p
Languages: English
NTIS Prices: PC A02/MF A01 Journal Announcement: GRAI8113
Country of Publication: United States

Ceramic cup soil-water samplers were used to determine the soil-water ionic concentrations of copper, iron, and sulfate within an acid spoil dump from 1974 to 1979. Over that time, samples from revegetated and nonrevegetated areas are compared. Differences in sample results cannot be attributed to the effects of revegetation.

829065 PB81-155905
Environmental Effects of Surface Mining of Minerals Other Than Coal: Annotated Bibliography and Summary Report
(Forest Service general technical rept.)
Richardson, Bland Z. ; Pratt, Marilyn Marshall
Intermountain Forest and Range Experiment Station, Ogden, UT.
Corp. Source Codes: 007568000
Report No.: FSGTR/INT-96
Nov 80 158p
Languages: English Document Type: Bibliography
NTIS Prices: PC A08/MF A01 Journal Announcement: GRAI8111
Country of Publication: United States

This bibliography contains annotated references to literature about the environmental effects of surface mining for minerals other than coal. Each reference is indexed by commodity, general subject, and environmental problem. The publication includes a section of references to unpublished, 'soft' literature and a summary of professional concerns about mining impacts throughout the United States.

827166 PB81-149742
Cellular Bioassay of Fish as a Sensitive Index of Water Quality Related to Mine Water
(Technical completion rept.)
Hinton, David E. ; Walker, Elizabeth R.
West Virginia Univ., Morgantown. Water Research Inst.
Corp. Source Codes: 015448063
Sponsor: Office of Water Research and Technology, Washington, DC.
Report No.: W81-00560; OWRT-A-037-WVA(1)
Sep 80 139p
Languages: English
NTIS Prices: PC A07/MF A01 Journal Announcement: GRAI8110
Country of Publication: United States
Contract No.: DI-14-34-0001-0152; OWRT-A-037-WVA

The overall objective was to develop a cellular bioassay useful in determining the effects of constituents of mine water (acid, pH, and metals) upon tissues and enzymes of freshwater fishes and to determine, via biological criteria, water quality. Coal-associated polynuclear aromatics caused induction of drug metabolizing enzymes in fish. Mn(++) caused enhanced metabolism of benzo (a) pyrene in-vitro but was inhibitory under in-vivo conditions in rainbow trout. Particulate iron (Fe2O3) suspended in aquarium water and Mn(++) caused gill alterations. Most subtle changes involved swelling of surface epithelial cells (both metals) and appearance of phagocytic cells in secondary lamellae (Fe2O3). Mn(++) caused a reduction in the surface microbridge of gill epithelial. A quantitative morphometric evaluation of control and acid-stressed (pH 4.0 or 5.0 by addition of H2SO4 to aquarium water) bullhead catfish showed a two-fold increase in the number of skin mucous cells of exposed fish, which was associated with an equivalent increase in volume density of skin mucosubstances. The three individual components of mine waters produced alterations which were easily differentiated from those produced by other agents and constitute evidence that cellular bioassay of target tissues in exposed fishes may yield valuable information relative to water quality.

822407 PB81-126765
Physical Environment and Hydrologic Characteristics of Coal-Mining Areas in Missouri
(Water-resources investigations (Final))
Vaill, Jerry E. ; Barks, James H.
Geological Survey, Rolla, MO. Water Resources Div.
Corp. Source Codes: 063175001
Report No.: USGS/WRD/WRI-80/076; USGS/WRI-80-67
Aug 80 39p
Languages: English
NTIS Prices: PC A03/MF A01 Journal Announcement: GRAI8108
Country of Publication: United States

Hydrologic information for the north-central and western coal-mining regions of Missouri is needed to define the hydrologic system in these areas of major historic and planned coal development. This report describes the physical setting, climate, coal-mining practices, general hydrologic system, and the current (1980) hydrologic data base in these two coal-mining regions. Streamflow in both mining regions is poorly sustained. Stream water quality generally varies with location and the magnitude of coal-mining activity in a watershed. Streams in non coal-mining areas generally have dissolved-solids concentrations less than 400 milligrams per liter. Acid-mine drainage has seriously affected some streams by reducing the pH to less than 4.0 and increasing the dissolved-solids concentrations to greater than 1,000 milligrams per liter. Ground water commonly contains high concentrations of iron and sulfate, and dissolved-solids concentrations generally are greater than 1,000 milligrams per liter.

820171 PB81-801649
Acid Mine Drainage. October, 1978-December, 1980 (Citations from the NTIS Data Base)
(Rept. for Oct 78-Dec 80)
Brown, Robena J.
National Technical Information Service, Springfield, VA.
Corp. Source Codes: 055665000
Dec 80 63p
Supersedes PB80-801478, and NTIS/PS-78/1067.
Languages: English Document Type: Bibliography
NTIS Prices: PC N01/MF N01 Journal Announcement: GRAI8107
Country of Publication: United States

The bibliography on acid mine drainage cites studies primarily concerning control and treatment methods. Reports on hydrogeology, ecology, formation, and sources are included. (This updated bibliography contains 56 citations, 26 of which are new entries to the previous edition.)

820170 PB81-801631
Acid Mine Drainage. 1964-September, 1978 (Citations from the NTIS Data Base)
(Rept. for 1964-Sep 78)
Brown, Robena J.
National Technical Information Service, Springfield, VA.
Corp. Source Codes: 055665000
Dec 80 277p
Languages: English Document Type: Bibliography
NTIS Prices: PC N01/MF N01 Journal Announcement: GRAI8107
Country of Publication: United States

The bibliography on acid mine drainage cites studies primarily concerning control and treatment methods. Reports on hydrogeology, ecology, formation, and sources are included. (This updated bibliography contains 270 citations, none of which are new entries to the previous edition.)

817920 PB81-801110
Coal Mine Waste. 1964-November, 1980 (Citations from the NTIS Data Base)
(Rept. for 1964-Nov 80)
Hundemann, Audrey S.
National Technical Information Service, Springfield, VA.
Corp. Source Codes: 055665000
Dec 80 233p
Supersedes PB80-804404, and NTIS/PS-79/0080.
Languages: English Document Type: Bibliography
NTIS Prices: PC N01/MF N01 Journal Announcement: GRAI8106
Country of Publication: United States

Research topics cover coal mining refuse, refuse dumps, and spoil. Studies on disposal, utilization, environmental impacts, and testing of these wastes are included, as are reports on land reclamation and spoil bank safety. (This updated bibliography contains 224 citations, 29 of which are new entries to the previous edition.)

817511 PB81-121261
Five-Year Water Resources Research Program
Huffsey, Ralph R.
Kentucky Water Resources Research Inst., Lexington.
Corp. Source Codes: 063998000
Sponsor: Office of Water Research and Technology, Washington, DC.
Report No.: W81-00285
Oct 80 69p
Languages: English
NTIS Prices: PC A04/MF A01 Journal Announcement: GRAI8106
Country of Publication: United States

Kentucky's water resource problems are grouped into two large areas, water quantity and water quality. The State's water quality is in general good with most streams being the calcium bicarbonate type. Kentucky has a statewide average rainfall of 45 inches per year and groundwater is plentiful in many parts of the State. Farming uses about 71 billion gallons annually; municipal, 71 billion gallons annually; and industry 220 billion gallons annually. Despite the current plentiful supply of water in Kentucky, problems do exist such as pollution, flooding, water hardness, erosion, acid mine drainage, and iron in the water.

811984 PB81-121337
Effects of Strip Mining the Abandoned Deep Anna S Mine on the Hydrology of Babb Creek, Tioga County, Pennsylvania
(Water-resources investigations (Interim))
Reed, Lloyd A.
Geological Survey, Harrisburg, PA. Water Resources Div.
Corp. Source Codes: 058888001
Report No.: USGS/WRD/WRI-80/072; USGS/WRI-80-53
Aug 80 49p
Prepared in cooperation with Environmental Protection Agency, Washington, DC., and Pennsylvania Dept. of Environmental Resources, Harrisburg.
Languages: English
NTIS Prices: PC A03/MF A01 Journal Announcement: GRAI8104
Country of Publication: United States

Daylighting (strip mining of coal seams previously deep mined) operations are being conducted on the Anna S Mine, That underlies about 850 acres that are drained by three major discharges. The Hunter Drift drain an underground area of about 400 acres, the Anna S 1, main entry, an area of 330 acres, and Mitchel 2 discharge an area of about 120 acres. As of August 1, 1979, about 55 acres (15 percent) had been daylighted in the Hunter Drift basin, about 15 acres (5 percent) in the Anna S main entry basin and about 30 acres (25 percent) in the Mitchel basin. The acidity of the Mitchel 2 discharge changed the most, from 176 milligrams per liter (as CaCO3) in 1975-76 to 1,190 in 1978-79, an increase of 580 percent.

308496 PB81-105827
Water Quality Modelling of Mine Acid Drainage
(Water resources and environmental engineering research rept. (Interim))
Uchida, Akira
State Univ. of New York at Buffalo. Dept. of Civil Engineering.
Corp. Source Codes: 045177038
Sponsor: National Science Foundation, Washington, DC.
Report No.: SUNYBUF/WREE-79-08
Aug 79 228p
Languages: English Document Type: Thesis
NTIS Prices: PC A11/MF A01 Journal Announcement: GRAI8102
Country of Publication: United States
Contract No.: NSF-ENG77-15365

Two steady-state, one-dimensional water quality models applicable to the streams receiving mine drainages are presented. The first model assumes chemical characteristics of the stream waters to be represented by the system of aqueous carbonate-sulfate equilibria. The exchange of carbon dioxide across the air-water interface was assumed to be the only significant sink-source of inorganic carbon. Essential aspects of the model were tested in a bench-scale laboratory experiment. A comprehensive model is then presented which takes into consideration kinetics of ferrous iron oxidation, growth and decay of iron-oxidizing bacteria, and interfacial

precipitation-dissolution reactions. The aqueous chemical system is modelled for forty-two species that are commonly present in mine drainage waters.

798378 PB80-221989
Water-Quality Assessment of the Cypress Creek Watershed, Warrick County, Indiana
(Final rept. Mar-Aug 79)
Bobo, Linda L. ; Peters, Charles A.
Geological Survey, Indianapolis, IN. Water Resources Div.
Corp. Source Codes: C3857100I
Report No.: USGS/WRD/WRI-80/039; USGS/WRI-80-35
May 80 74p
Prepared in cooperation with Soil Conservation Service, Washington, DC.
Languages: English
NTIS Prices: PC A04/MF A01 Journal Announcement: GRAI8025
Country of Publication: United States

Past and present surface coal mining is the factor having the greatest impact on water quality in the watershed. The general water type of Cypress Creek and most of its tributaries is calcium and magnesium sulfate. The water type at background site 21 on Summer Pecks ditch is calcium sulfate. Specific conductance ranged from 470 to 4,370 micromhos per centimeter at 25 degrees Celsius, and pH ranged from 1.2 to 8.8. Specific conductance, hardness, and concentrations of major ions and dissolved solids were highest in tributaries affected by mining. The pH was lowest in the same tributaries. Concentrations of iron, manganese, and sulfate in water samples and chlordane, DDT, and PCB's (polychlorinated biphenyls) in streambed samples exceeded water-quality limits.

789240 PB80-201908
Effect of Surface Coal Mining on the Hydrology of Crooked and Turkey Creek Basins, Jefferson County, Alabama
(Water-resources investigations (Interim))
Puente, Celso ; Newton, J. G.
Geological Survey, University, AL. Water Resources Div.
Corp. Source Codes: 060344001
Report No.: USGS/WRI-79-91; USGS/WRD/WRI-80/031
Aug 79 48p
Languages: English
NTIS Prices: PC A03/MF A01 Journal Announcement: GRAI8022
Country of Publication: United States

Streamflow, sediment yield, and water quality were monitored from October 1975 through May 1977 to determine the impact of surface coal mining on the hydrology of Crooked and Turkey Creek basins in Jefferson County, Alabama.

789124 PB80-200363
Analysis of Selected Samples for Metals Uptake
(Draft rept. (Final) Sep 78-Mar 79)
Schultz, Lee
Hittman Associates, Inc., Columbia, MD.
Corp. Source Codes: 068531000
Sponsor: Industrial Environmental Research Lab.-Cincinnati, OH. Extraction Technology Branch.
Report No.: HIT-C0194/002-78-765D; EPA-600/7-80-098
13 Mar 79 62p
Languages: English
NTIS Prices: PC A04/MF A01 Journal Announcement: GRAI8022
Country of Publication: United States
Contract No.: EPA-68-03-2664

Grass samples were collected from the Contrary Creek/D. Boyd Smith reclamation project of the Virginia Water Quality Control Board and the Anvil Points mine treatment experimental facility. Fish samples were collected from the EPA's mine water treatment experimental facility's sludge pond near Crown, West Virginia. Samples were analyzed for arsenic, boron, cadmium, chromium, copper fluorine, iron, mercury, lithium, manganese, molybdenum, nickel, phosphorus, lead, selenium, vanadium, and zinc. Various quality control procedures were applied and analyzed statistically in the report.

786731 PB80-188245
Environmental Effects of Western Coal Surface Mining. Part VII. Microbial Effect on the Quality of Leach Water from Eastern Montana Coal Mine Spoils
(Final rept.)
Kimble, Patrick F. ; Temple, Kenneth L.
Montana State Univ., Bozeman. Dept. of Microbiology.
Corp. Source Codes: 012306028
Sponsor: Environmental Research Lab.-Duluth, MN.
Report No.: EPA-600/3-80-046
May 80 91p
See also Part 5, PB80-186521.
Languages: English
NTIS Prices: PC A05/MF A01 Journal Announcement: GRAI8021
Country of Publication: United States
Contract No.: EPA-R-803950

Selected portions of test cores from the overburden of the West Moorhead coal deposit in southeastern Montana were examined for possible addition to leach water of toxic substances and for the presence of iron and sulfur bacteria which might contribute to leaching. Leachates were evaluated by measuring pH, lead, and the effect of the leachates on the Selenastrum algal assay.

782194 PB80-204340
Occurrence and Activity of Iron and Sulfur-Oxidizing Microorganisms in Alkaline Coal Strip Mine Spoils
Olson, G. J. ; McFeters, G. A. ; Temple, K. L.
Montana Water Resources Research Center, Bozeman.
Corp. Source Codes: 034336000
Sponsor: Office of Water Research and Technology, Washington, DC.
Report No.: MWRRC-105; W80-05404; OWRT-B-050-MONT(1)
Mar 80 25p
Prepared in cooperation with National Bureau of Standards, Washington, DC.
Languages: English
NTIS Prices: PC A02/MF A01 Journal Announcement: GRAI8019
Country of Publication: United States
Contract No.: DI-14-34-0001-9081; OWRT-B-050-MONT

Spoils samples collected from a coal strip mine in southeastern Montana were examined for populations and activities of iron- and sulfur-oxidizing bacteria. Spoils examined were of three types: (1) acidic pyrite-rich waste coal, (2) oxidation halo material, and (3) alkaline, which was the most widespread type. Bacterial numbers, sulfur oxidation, and 14CO2 uptake activity declined to low levels in the summer when spoils were dry. Even in wetter spring months pyritic spoils contained relatively low numbers of acidophilic iron- and sulfur-oxidizing bacteria, probably indicative of water stress since the same spoils incubated with excess water or dilute mineral salts showed considerably greater bacterial numbers and activity. Certain wells in coal and spoils aquifers contained substantial populations of iron-oxidizing acidophilic bacteria. However, these wells were always of alkaline or neutral pH indicating that bacterial pyrite oxidation occurred in localized areas where groundwaters contacted either replaced spoils or coal which contained either pyrite or other metal sulfides. Bacterial activity may contribute to trace metal and sulfate leaching which occur in the area.

759430 PB80-137219
Rotating Disc Biological Treatment of Acid Mine Drainage
(Final rept. May 77-Oct 78)
Olem, Harvey ; Unz, Richard F.
Pennsylvania State Univ., University Park.
Corp. Source Codes: 008222000
Sponsor: Industrial Environmental Research Lab., Cincinnati, OH.
Report No.: EPA-600/7-80-006
Jan 80 132p
Languages: English
NTIS Prices: PC A07/MF A01 Journal Announcement: GRAI8012
Country of Publication: United States
Contract No.: EPA-R-805132

Pilot scale (0.5-m diameter) and prototype (2.0-m diameter) rotating biological contactors (RBC) were investigated for oxidation of ferrous Fe(II) iron contained in six heterogeneous mine waters located at three coal mining sites in Pennsylvania and West Virginia. Continuous biological oxidation of Fe(II) and Fe(III) was accomplished at natural mine water temperatures as low as 0.4C at Hawk Run, PA. and as high as 29C at Crown, WV. Reduction of Fe(II) oxidation efficiency at 0.4C amounted to 10 to 20 percent of that achieved at 10C. Oxidation efficiency was above 80 percent at mine water temperatures of 10 to 29C. Microbiological oxidation with the 0.5-m RBC was unaffected at influent mine water pH values in the range of 2.18 to 5.50 (Crown, WV.). Fe(II) oxidation was an average 10 percent less efficient for a mine water treated under similar operating conditions with the 2.0-m than with the 0.5-m RBC. The observed decrease may be due to nonmicrobiological factors such as increased short-circuiting, lower residence time, and a smaller effective surface area which may be increased through proper design. Costs for Fe(II) oxidation with the RBC were estimated to be about twice the amortized capital costs and one-half the operating costs compared to a conventional chemical oxidation process. Neutralization of RBC effluent and separation of precipitated iron solids is required to produce water of suitable quality for stream-release. Both iron-oxidizing and heterotrophic bacteria existed in a gelatinous matrix present on disc surfaces of RBC units operating at Hollywood, PA.

754349 PB80-805450
Uranium Mining and Milling Environmental Studies (Citations from the Engineering Index Data Base)
(Rept. for 1970-Feb 80)
Hundemann, Audrey S.
National Technical Information Service, Springfield, VA.
Corp. Source Codes: 055665000
Feb 80 107p
Supersedes NTIS/PS-79/0140 and NTIS/PS-78/0049. For the companion Published Search of the NTIS Data Base, see PB80-805443.
Languages: English Document Type: Bibliography
NTIS Prices: PC N01/MF N01 Journal Announcement: GRAI8009
Country of Publication: United States

Worldwide research is cited on uranium mining waste management and effluent control. Studies on mining practices, radon monitoring, health hazards, and land reclamation are covered. Government policies and regulations concerning present and long term waste handling are included. (This updated bibliography contains 110 abstracts, 24 of which are new entries to the previous edition.)

752181 PB80-804404
Coal Mine Waste (Citations from the NTIS Data Base)
(Rept. for 1964-Jan 80)
Hundemann, Audrey S.
National Technical Information Service, Springfield, VA.
Corp. Source Codes: 055665000
Feb 80 202p
Supersedes NTIS/PS-79/0080, NTIS/PS-78/0052, and NTIS/PS-77/0040.
Languages: English Document Type: Bibliography
NTIS Prices: PC N01/MF N01 Journal Announcement: GRAI8008
Country of Publication: United States

Research topics cover coal mining refuse, refuse dumps, and spoil. Studies on disposal, utilization, environmental impacts, and testing of these wastes are included, as are reports on land reclamation and spoil bank safety. (This updated bibliography contains 195 abstracts, 38 of which are new entries to the previous edition.)

742128 PB80-801475
Acid Mine Drainage (A Bibliography with Abstracts)
(Rept. for 1964-Sep 79)
Brown, Robena J.
National Technical Information Service, Springfield, VA.
Corp. Source Codes: 055665000
Dec 79 279p
Supersedes NTIS/PS-78/1067, NTIS/PS-77/0949, NTIS/PS-76/081-6, NTIS/PS-75/714, and NTIS/PS-75/046.
Languages: English Document Type: Bibliography
NTIS Prices: PC N01/MF N01 Journal Announcement: GRAI8003
Country of Publication: United States

The bibliography on acid mine drainage cites studies primarily concerning control and treatment methods. Reports on hydrogeology, ecology, formation, and sources are included. (This updated bibliography contains 300 abstracts, 30 of which are new entries to the previous edition.)

716371 PB-295 802/3
Gamma Radiation Treatment of Waters from Lignite Mines
(Final rept. Sep 74-Aug 78)
Janiak, Henryk
Central Research and Design Inst. for Opencast Mining, Wroclaw (Poland).
Sponsor: Industrial Environmental Research Lab., Cincinnati, OH. Resource Extraction and Handling Div.
Report No.: EPA/600/7-79/064
Feb 79 106p
Languages: English
NTIS Prices: PC A06/MF A01 Journal Announcement: GRAI7918
Contract No.: EPA-05-534-3

Discussed in this report are results of laboratory investigations carried out with the application of gamma radiation for the purification of waters drained from surface lignite mines. These waters are polluted to a considerable extent with suspended matter of various sizes, a large quantity of which is colloidal particles, mainly clay, that create turbidity and colour. Moreover there is often a high oxygen demand and occasionally a high content of iron. The remaining chemical physical parameters of the mine water do not diverge from the levels required for waters discharged to surface flows and reservoirs. The investigations have shown a positive influence of Co-60 gamma radiation on the speed of suspended matter sedimentation, starting with an absorbed dose of 500 kRad. An optimal dose was found to be 1000 kRad. Above this dose the acceleration of velocity of settling particles was not proportional to the applied energy value. The investigations found relationship between the absorbed dose and the reduction in turbidity, oxygen demand and iron content.

708753 LA-UR-78-3151
Environmental Control Technology for Contaminated Drainage from Coal and Coal Wastes
Wewerka, E. M. ; Bertino, J. P. ; Wagner, P. ; Williams, J. M. ; Wanek, P. L.
Los Alamos Scientific Lab., NM.
Corp. Source Codes: 3820000
Sponsor: Department of Energy.
Report No.: CONF-781109-19
1978 12p
Environmental control symposium, Washington, DC, USA, 28 Nov 1978.
Languages: English Document Type: Conference proceeding
NTIS Prices: PC A02/MF A01 Journal Announcement: GRAI7915 ; NSA0400
Contract No.: W-7405-ENG-36

The aqueous drainage from coal piles and coal refuse dumps frequently is contaminated with acids and a variety of trace elements and inorganic constituents. The Los Alamos Scientific Laboratory is conducting research, jointly supported by DOE/ECT and EPA, to assess the nature and magnitude of trace elements in the drainage from coals and coal preparation wastes, to identify the trace elements of environmental concern in these effluents, and to define necessary environmental control technology for this form of environmental pollution. The current emphasis of this program is on the laboratory assessment of environmental control options for the drainages from high sulfur coals and coal wastes. This presentation reviews some of the accomplishments of this research program to data, and discusses the various drainage control options available to the coal industry. (ERA citation 04:021248)

704941 PB-292 701/0
Environmental Effects of Western Coal Surface Mining. Part III: The Water Quality of Trout Creek, Colorado
(Final rept.)
Skogerboe, R. K. ; Lavallee, C. S. ; Miller, M. M. ; Dick, D. L.
Colorado State Univ., Fort Collins. Dept. of Chemistry.
Corp. Source Codes: 404992
Sponsor: Environmental Research Lab., Duluth, MN.
Report No.: EPA/600/3-79/008
Jan 79 71p
See also Part 2, dated Oct 78, PB-289 883.
Languages: English
NTIS Prices: PC A04/MF A01 Journal Announcement: GRAI7913
Contract No.: EPA-R-803950

Water quality parameters have been measured at several on-stream and off-stream sites along Trout Creek, which is recipient of water from coal strip-mining operations. Levels of the gross parameters (e.g., specific conductivity), the common ions (e.g., calcium and sulfate), and some trace components (e.g., selenium) are highest in mine spoil drainages. The impact of the mine spoil drainage on the stream is reflected in the larger quantities of dissolved solids and common ions found at on-stream sites adjacent to and below the mine. For trace elements, the mine operation has no detectable impact on Trout Creek in terms of increasing concentrations of Al, As, Cd, Cr, Cu, Fe, Pb, or Zn. Increases in stream concentrations of Mn and Se due to mine inflow can be inferred from the data. Higher concentrations of As, Fe, Mn, Se, and Zn are found in waters draining mine spoils. In the mine spoils, variations in the concentrations of these elements occur with spoil age; more Mn and Zn occur in older spoils, while higher levels of As, Fe, and Se are found in newer spoils. Chemical equilibrium calculations indicate that alkaline precipitation processes can maintain the low concentrations of Al, Cd, Cu, Fe, Pb, and Zn. The general alkaline characteristics of western streams and aquifers suggests that such precipitation equilibria will limit the soluble heavy metal concentrations.

699581 PB-290 614/7
Adsorption and Desorption in Mine Drainages
(Master's thesis)
Holcombe, Lawrence Jay
Colorado School of Mines, Golden.
Sponsor: Office of Water Research and Technology, Washington, DC.
Report No.: W79-03673; OWRT-A-034-COLO(2)
1977 105p
Languages: English Document Type: Thesis
NTIS Prices: PC A06/MF A01 Journal Announcement: GRAI7911
Contract No.: DI-14-34-0001-7012; OWRT-A-034-COLO

This report analyzes the solid sediment deposited in a mine drainage and its effect on the solution chemistry; specifically, the adsorption of heavy metals by the hydrous oxides of manganese and iron. Forty-two sediment samples were collected from mine drainages in the Front Range and sieved to minus eighty mesh. A selective chemical attack on the sediments with a hydroxylamine hydrochloride and acetic acid mixture showed that manganese oxides controlled the amount of Co, Cu, Cd, Zn and Ni in the sediment. Hydrous oxides of iron, did not adsorb metals from solution and had a negative correlation with Mg, Al, Ca, Na, K, Cu, Pb, Ni, Mn, Zn, Co, and Cd. The sorption behaviors of manganese and iron hydrous oxides are strongly controlled by pH. At the low pH's of the mine drainages, iron oxides have a positive surface charge, thus preventing the adsorption of cations; manganese oxides have a negative surface charge at these pH's. Through the extraction method it was found that a large portion of the mine drainage sediments are adsorbed on precipitated material, the exact percentage being dependent on pH, Eh, complexing agents, stream flow, sediment distribution co-efficients and other factors. A model was designed and tested which will enable an experimentor to determine the distribution or isotherm for a metal between its aqueous form and as a sorbed species. The isotherm method involves equilibration of a metal in solution with complexing agents and ion-exchangers, with subsequent determination of all forms of the metal. The ion-exchange method was used to determine the free metal and complexed metal concentrations in solution. Under ideal laboratory conditions, using synthetic exchangers and controlled solution parameters, the isotherm method was accurate in determining the 'true' isotherm for Zn(II) when citrate was present as a complexer.

697127 PB-291 688/0
Water Movement in Uranium Mill Tailings Profiles
(Final rept. Apr 76-Sep 78)
Klute, A. ; Heermann, D. F.
Science and Education Administration, Fort Collins, CO. Agricultural Research.
Sponsor: Office of Radiation Programs, Las Vegas, NV.
Report No.: ORP/LV-78/8
Sep 78 98p
Languages: English

The objective of this study was to characterize the behavior of water in profiles of uranium mill tailings. The approach taken consisted of (1) measurement of the water retention and transmission properties of selected tailings materials, (2) numerical simulation of water flow in selected profiles of tailings subjected to specific boundary conditions, and (3) analysis and interpretation of the simulation results within the framework of unsaturated soil water flow theory. The sequence of flow events in a tailings profile without vegetation and with a water table at a given depth is: (1) an initial drainage from saturation, with evaporation at the surface, (2) infiltration of varying amounts of rain at irregular intervals, (3) and periods of evaporation and drainage from the profile, with redistribution within the profile, between infiltration events. The water flow regime in the upper 90 cm, particularly the upper 10-20 cm is transient and dynamic. The lower part of the profile, below about 70-90 cm, tends to behave in a quasi-steady downward flow condition.

696367 NTIS/PS-79/0140/8
Uranium Mining and Milling Environmental Studies (Citations from the Engineering Index Data Base)
(Rept. for 1970-Jan 79)
Hundemann, Audrey S.
National Technical Information Service, Springfield, VA.
Corp. Source Codes: 391812
Mar 79 90p
Supersedes NTIS/PS-78/0049. For the companion Published Search of the NTIS Data Base, see NTIS/PS-79/0139.
Languages: English Document Type: Bibliography
NTIS Prices: PC N01/MF N01 Journal Announcement: GRAI7910

Worldwide research is cited on uranium mining waste management and effluent control. Studies on mining practices, radon monitoring, health hazards, and land reclamation are covered. Government policies and regulations concerning present and long term waste handling are included. (This updated bibliography contains 86 abstracts, 15 of which are new entries to the previous edition.)

695429 ANL/LRP-TM-8
Abandoned Mine Land Reclamation Plan
O'Connor, S. H. ; Zellmer, S. D.
Argonne National Lab., IL.
Corp. Source Codes: 0448000
Sponsor: Department of Energy.
1977 34p
Languages: English
NTIS Prices: PC A03/MF A01 Journal Announcement: GRAI7910 ; NSA0400
Contract No.: W-31-109-ENG-38

The responsibility of an abandoned mine land reclamation plan must be to gather information concerning the number of acres, location, ownership, condition, environmental damage resulting from the condition, the cost of acquiring and reclaiming the land. Possible future uses, legal tools available to the state, and incentives to private interests in reclaiming the land must be considered. Factors which should be dealt with when compiling this information include: geology, topography, surface drainage, the productivity and structural qualities of the soils, habitat and vegetation, climatological data, existing land use and a visual analysis. Information necessary in making determinations concerning future land uses include: socio-economic characteristics, demographic trends, historical development, transportation and water supply. This study demonstration project concerns itself with the area located within the southeastern portion of Macoupin County, 60 miles southwest of Springfield, Illinois. In general, the groundwater from shallow wells in the area is very hard and contains large quantities of iron. The surface waters have also been affected to some degree by the refuse piles. (ERA citation 04:005087)

693961 NTIS/PS-79/0080/6
Coal Mine Waste (A Bibliography with Abstracts)
(Rept. for 1964-Jan 79)
Hundemann, Audrey S.
National Technical Information Service, Springfield, VA.
Corp. Source Codes: 391812
Mar 79 163p
Supersedes NTIS/PS-78/0052, NTIS/PS-77/0040, NTIS/PS-76/005-3, and NTIS/PS-75/112.
Languages: English Document Type: Bibliography
NTIS Prices: PC N01/MF N01 Journal Announcement: GRAI7909

Research topics cover coal mining refuse, refuse dumps, and spoil. Studies on disposal, utilization, environmental impacts, and testing of these wastes are included, as are reports on land reclamation and spoil bank safety. (This updated bibliography contains 157 abstracts, 19 of which are new entries to the previous edition.)

686461 PB-288 210/8
Source Assessment: Coal Refuse Piles, Abandoned Mines and Outcrops, State-of-the-Art
(Final rept. Aug 75-Jul 77)
Chalekode, P. K. ; Blackwood, T. R.
Monsanto Research Corp., Dayton, OH.
Sponsor: Industrial Environmental Research Lab.-Cincinnati, OH.
Report No.: MRC-DA-707; EPA/600/2-78/004V
Jul 78 52p
Languages: English
NTIS Prices: PC A04/MF A01 Journal Announcement: GRAI7905
Contract No.: EPA-68-02-1874

This report describes a study of atmospheric emissions from coal refuse piles, abandoned mines, and outcrops. The potential environmental effect of the source was evaluated using source severity (defined as the ratio of the maximum time-averaged ground level concentration of an emission to a hazard factor). Burning of coal piles, impoundments, abandoned mines, and outcrops results in emissions of various pyrolysis and combustion products such as particulates, nitrogen oxides, sulfur oxides, carbon monoxide, hydrogen sulfide, ammonia, polycyclic organic materials (POM), and hydrocarbons, including benzene, toluene, and xylene. Trace elements such as arsenic, boron, and mercury are also emitted.

684168 PB-287 511/0
Availability of Mining Wastes and Their Potential for Use as Highway Material - Executive Summary
(Final summary rept. Jun 75-Jun 76)
Collins, R. J. ; Miller, R. H.
Valley Forge Labs., Inc., Devon, PA.
Sponsor: Federal Highway Administration, Washington, DC.
Report No.: FHWA/RD-78/28
Sep 77 47p
See also Volume 3 dated May 76, PB-266 172.
Languages: English
NTIS Prices: PC A03/MF A01 Journal Announcement: GRAI7904
Contract No.: DOT-FH-11-8784

This study was performed to determine the availability of mining and metallurgical wastes in the United States and to assess their potential for use in various aspects of highway construction. A comprehensive literature survey was performed to develop information on locations amounts, compositions, and uses of various mining and metallurgical wastes.

677838 GJT-21

Laboratory Research on Tailings Stabilization Methods and Their Effectiveness in Radiation Containment

Macbeth, P. J. ; Jensen, C. M. ; Rogers, V. C. ; Overmyer, R. F.

Ford, Bacon and Davis Utah, Inc., Salt Lake City.

Corp. Source Codes: 9502722

Sponsor: Department of Energy.

Apr 78 112p

NTIS Prices: PC A06/MF A01 Journal Announcement: GRAI7826 ; NSA0300

Contract No.: EY-76-C-13-1658

This report describes a study of various methods, techniques, and materials for stabilizing uranium mill tailings to reduce radon exhalation. Radon emanation from tailings particles, radon exhalation from tailings, and methods that could be used to reduce radon exhalation from tailings piles are discussed. Surface radon flux and soil gas concentrations were measured in experiment chambers or columns consisting of uranium tailings and various types and thicknesses of cover materials. The applicability of diffusion theory was examined and effective diffusion coefficients were determined for clay, soil, and sand. The variation of radon flux with atmospheric effects and moisture also was investigated. The effectiveness of several types of chemical stabilizers for both volumetric and surface application in reducing radon exhalation is reported. Some volumetric stabilizers reduced radon flux by 90 percent or more. Radon flux was determined through the use of charcoal gas mask canisters, and flux accumulation chambers sampled by Lucas cells. Both of these techniques are described. Soil gas concentration was sampled with Lucas cells and counted with a sodium iodide scintillation spectrometer system. Emanating power of uranium tailings was measured for several particle sizes and found to be relatively constant at about 20 percent. Two types of grasses were found that would grow in tailings if sufficient water and fertilizer were provided. The effect of vegetation on radon exhalation was not determined. (ERA citation 03:045314)

677135 PB-286 034/4

Uranium Mining and Milling. The Need, the Processes, the Impacts, the Choices. Administrator's Guide

(Final rept.)

Western Interstate Energy Board, Denver, CO.

Sponsor: Stone and Webster Engineering Corp., Denver, CO.; Environmental Protection Agency, Denver CO. Region VIII.

Report No.: EPA/908/1-78/004

May 78 274p

Prepared by Stone and Webster Engineering Corp., Denver, CO.

NTIS Prices: PC A12/MF A01 Journal Announcement: GRAI7826

Contract No.: EPA-68-01-4490

The primary objective of the Guide is to address the technical, economic, social, and environmental factors that influence uranium mining and the siting of milling facilities in the western United States. Although the Guide is not a regulatory document, the information should be useful to local, state, and federal administrators, legislators, policy makers, planners, and regulators involved in the review or approval process for uranium projects. The information should also be of interest to citizens who would be affected by a proposed project. The Guide also highlights information that is considered by industry during the planning process. For example, site-specific aspects of mill tailings management are receiving increased attention from regulators and industry, and some earlier tailings disposal practices are no longer acceptable. A secondary objective of the Guide is to inform developers of the various options that may be available when planning uranium development projects. Although the location of the mine is fixed, there are options available in the design of the mill, such as alternative sites, process methods, waste disposal locations and pollution control techniques.

677110 PB-285 990/8

An Evaluation of the Application of a Dual-Functional Filter to Dewatering Neutralized Acid-Mine-Water Sludge

Henry, Jr., Joseph D. ; Kuo, C. H. Alex

West Virginia Univ., Morgantown. Water Research Inst.

Sponsor: Office of Water Research and Technology, Washington, DC.

Report No.: WRI-WVU-78-01; INFORMATION-10; W78-11218; OWRT-A-028-WVA(1)

1978 64p

NTIS Prices: PC A04/MF A01 Journal Announcement: GRAI7826

Contract No.: DI-14-31-0001-4049; OWRT-A-028OWVA

The dual-functional filter, a solid-liquid separation device employing both the mechanisms of filtration and settling or decantation, includes a filtration and dump cycle where settling occurs. A design equation for the filter was developed which facilitated data interpretation and assessment of the feasibility of the process. Alternatives for integrating the dual-functional filter with acid-mine-water-treatment processes were evaluated. Economic evaluation of the costs of a clarifier-filter sequence was used to determine the optimum extent of dewatering prior to filtration. The optimum interstage-slurry concentration between the clarifier and the dual-functional filter for the base case is 0.6 wt-percent. The total treatment cost is 10.3 cents per 1000 gallons. Economic-sensitivity analyses illustrate the effect of changes in the fractional redispersion of the filter cake, cycle time, and hose life. The economics are labor controlled. The labor cost is approximately 70 percent of the total treatment cost for the basic case.

677076 PB-285 938/7
Miscellaneous Data and Information Collected During Radiation Surveys at the Former Monument Uranium Mill Site (1974-1975)
(Technical Note)
Hans, Jr, Joseph M.
Office of Radiation Programs, Las Vegas, NV.
Jul 78 49p
NTIS Prices: PC A03/MF A01 Journal Announcement: GRAI7826

The purpose of the surveys was to delineate the spread and depth of ore and mill tailings in order that cost estimates could be made for their removal and interim stabilization of the tailings piles. The results of the surveys were prepared in summary form and very little data was made available. This report presents the data and information collected at the former Monument Uranium Mill site. The data includes gamma radiation background measurements, bore hole logging data, ground water analysis, gamma surveys, and radionuclide concentrations versus depth in soil. Interpretation of the data is made where possible. It appears, from bore hole logs, that a substantial amount of uranium is still present at the mill site.

675285 PB-286 520/2
Development Document for the Effluent Limitations and Guidelines for the Ore Mining and Dressing Point Source Category. Volume I
(Final rept.)
Jarrett, Baldwin M. ; Kirby, Ronald G.
Environmental Protection Agency, Washington, D.C. Effluent Guidelines Div.
Report No.: EPA/440/1-78/061D
Jul 78 424p
NTIS Prices: PC A18/MF A01 Journal Announcement: GRAI7825

To establish effluent limitation guidelines and standards of performance, the ore mining and dressing industry was divided into 41 separate categories and subcategories for which separate limitations were recommended. This report deals with the entire metal-ore mining and dressing industry and examines the industry by ten major categories: iron ore; copper ore; lead and zinc ores; gold ore; silver ore; bauxite ore; ferroalloy-metal ores; mercury ores; uranium, radium and vanadium ores; and metal ores, not elsewhere classified ((ores of antimony, beryllium, pltinum, rare earths, tin, titanium, and zirconium). The subcategorization of the ore categories is based primarily upon ore mineralogy and processing or extraction methods employed; however, other factors (such as size, climate or location, and method of mining) are used in some instances. With the best available technology economically achievable, facilities in 21 of the 41 subcategories can be operated with no discharge of process wastewater to navigable waters. No discharge of process wastewater is also achievable as a new source performance standard for facilities in 21 of the 41 subcategories.

674614 NTIS/PS-78/1067/4
Acid Mine Drainage (A Bibliography with Abstracts)
(Rept. for 1964-Sep 78)
Brown, Robena J.
National Technical Information Service, Springfield, Va.
Corp. Source Codes: 391812
Oct 78 275p
Supersedes NTIS/PS-77/0949, NTIS/PS-76/0816, NTIS/PS-75/714, and NTIS/PS-75/046.
Document Type: Bibliography
NTIS Prices: PC N01/MF N01 Journal Announcement: GRAI7825

The bibliography on acid mine drainage cites studies primarily concerning control and treatment methods. Reports on hydrogeology, ecology, formation, and sources are included. (This updated bibliography contains 270 abstracts, 50 of which are new entries to the previous edition.)

669816 CANMET-76-19
Disposal of Solid Wastes and Liquid Effluents from the Milling of Uranium Ores
Moffett, D.
Canada Centre for Mineral and Energy Technology, Ottawa (Ontario).
Corp. Source Codes: 2123650
Jul 76 76p
U.S. Sales Only.
NTIS Prices: PC A05/MF A01 Journal Announcement: GRAI7823

Current Canadian practice in the milling of uranium-bearing ores commonly involves fine grinding followed by acid leach/ion exchange. The acid leach may be followed instead by solvent extraction. Alkaline leaching has been done, and in situ bacteriological leaching is of interest. Tailings disposal operations are necessary and create environmental problems. Uranium-mill wastes are unique because of their radioactivity. Some of the radioisotopes present may require an individual control procedure. Radium-226 is particularly important because it is the most hazardous of all isotopes found in the tailings. Acid and heavy-metal removal is conventionally done by the addition of lime, but other means are available, such as with limestone, sodium hydroxide, ammonia, silicon alloys or by sulphide precipitation. Modifications to unit operations in the mill process may be required to produce more acceptable effluents. Increased water recycling may be necessary to meet regulatory standards. (Atomindex citation 09:361125)

665571 PB-283 064/4
The Uranium Mill Tailings Cleanup: Federal Leadership at Last
General Accounting Office, Washington, D.C. Energy and Minerals Div.
Report No.: EMD-78-90
20 Jun 78 60p
NTIS Prices: PC A04/MF A01 Journal Announcement: GRAI7821

The Department of Energy has proposed legislation that would allow it to enter into cooperative agreements with various States to clean up residual radioactive materials--commonly called uranium mill tailings--at 22 inactive uranium mills. About 25 million tons of mill tailings have accumulated at these sites since the 1940s. GAO analyzed the need for, and adequacy of, the proposed legislation and recommends that the cleanup program be endorsed. While the Federal Government has no apparent legal responsibility for such a cleanup, it does have a moral responsibility since the mills primarily produced uranium for Federal programs. Further, it is the only organization able to undertake such a cleanup program on a comprehensive basis. GAO also suggests several areas where the proposed legislation could be strengthened.

664747 DOCKET-408584-1
Sweetwater Uranium Project. Draft Environmental Statement
Nuclear Regulatory Commission, Washington, D.C. Office of Nuclear Material Safety and Safeguards.
Corp. Source Codes: 9502169
Report No.: NUREG-0403(DR)
Dec 77 197p
NTIS Prices: PC A09/MF A01 Journal Announcement: GRAI7821 ; NSA0300

The proposed action is the issuance of a Source Material License to Minerals Exploration Company for the construction and operation of the proposed Sweetwater Uranium Mill with a nominal capacity of 3000 tons (2.7 x 10 exp 6 kg) per day of uranium ore in Wyoming. The applicant proposes also to construct a heap-leaching and resin ion-exchange facility to extract uranium from low-grade ores and mine water. Impacts to the area due to the operation of the Sweetwater Uranium Mine/Mill Project will result in: Alternations of up to 2200 acres by the mill, mine pit area, and roads, and about 3450 acres of Battle Spring Flat to be inundated by mine dewatering operations; increase in the existing background radiation levels; socioeconomic effects on Rawlins and other nearby areas; and tailings from the mill will be produced at a rate of about 3000 tons (2.7 x 10 exp 6 kg) per day and will be stored onsite in a lined impoundment. Conditions for the issuance of the license are given. (ERA citation 03:037006)

659373 PB-282 392/0
Above Ground Gamma Ray Logging for Locating Structures and Areas Containing Elevated Levels of Uranium Decay Chain Radionuclides
(Technical note (Final))
Hans, Jr., Joseph M. ; Eadie, Gregory G. ; Thrall, Jack ; Peterson, Bruce
Office of Radiation Programs, Las Vegas, Nev.
Report No.: ORP/LV-78/2
Apr 78 46p
NTIS Prices: PC A03/MF A01 Journal Announcement: GRAI7819

This report describes the construction and operation of a mobile gamma ray logging system used to locate areas and structures containing elevated levels of natural uranium decay chain radionuclides. The detector system consists of a sodium iodide crystal coupled to four photomultiplier tubes and associated electronic system which permits both an audible indication and a strip chart recording of gamma ray photon count rates. Under normal operations, the detector assembly is mounted in a van at about two meters above the ground surface and gamma ray logs are obtained while travelling at about 16 kilometers per hour (10 mph). This system has been used extensively in the Pocatello and Soda Springs, Idaho areas and identified about 1900 locations where phosphate slag has been used for various construction purposes. The system has also been used in several other communities to identify locations where uranium mill tailings or pumice, containing slightly elevated concentrations of natural radioactivity, was used for construction purposes.

653900 PB-280 851/7
Bioelectric Neutralization of Acid Waters
(Patent)
Sisler, Frederick D. ; Senftle, Frank E.
Department of the Interior, Washington, D.C.
Corp. Source Codes: 109950
Report No.: PAT-APPL-819 518; PATENT-4 072 798
Filed 28 Jul 77 patented 7 Feb 78 7p
Supersedes PB-275 560. Also includes Rept. no. DOCKET/SUR-2559.

This Government-owned invention available for U.S. licensing and, possibly, for foreign licensing. Copy of patent available Commissioner of Patents, Washington, D.C. 20231 $0.50.

Document Type: Patent
NTIS Prices: Not available NTIS Journal Announcement: GRAI7817

An apparatus is to be used in a process for bioelectric neutralization of a body of water having a bottom of anaerobic mud and an acid supernatant liquid. The apparatus comprises a buoy riding on the surface of the water, and upper electrode preferably of carbon suspended from the buoy in the acid supernatant liquid, a lower electrode preferably of iron embedded in the anaerobic mud and a flexible, insulated electrical conductor preferably an insulated copper cable, conductively attached to the upper and lower electrodes. A plurality of sets of apparatus may be used spaced apart from each other in the body of water. It is an object of this invention to provide a process for neutralizing acid-polluted water found in strip-mine lakes and in rivers which accept the acid effluent from manufacturing processes, and to provide an apparatus suitable for the process.

652874 NP-22748
Continued Studies of Soil Improvement and Revegetation of Tailings Sand Slopes. Environmental Research Monograph 1977-4
Rowell, M. J.
Syncrude Canada Ltd., Edmonton, Alberta.
Corp. Source Codes: 9698018
1977 173p
U.S. Sales Only.
NTIS Prices: PC A08/MF A01 Journal Announcement: GRAI7817 ; NSA0300

Fertilizer studies continued on a 5-year old revegetated area on a tailings sand dike in the Athabasca Tar Sands area. In June 1976 levels of available N, P, K, and S were adequate for plant growth. However, even where fertilizers were added levels of mineral N had dropped to low levels by September. Plant top production early in the 1976 season was increased by application of nitrogen fertilizer during the previous August. Erosion of the area was negligible in 1976. In the new revegetation experiments on steep tailings and slopes, erosion could be minimized by the rapid establishment of a plant cover. Nutrient losses in surface water runoff amounted to a maximum of only 2.6 kg N, 0.4 kg P, 4.1 kg K and 3.4 kg S/ha in the treatments studied. Water infiltration into the dike was rapid and varied between 24.0 and 30.5 cm/h. Estimates suggested that between 13 and 34% of the intercepted rainfall leached below the 30 cm depth while plants were being established during the first year of growth. Estimates of nutrient losses below the root zone (30 cm) ranged between 1.3 and 31.2 kg N/ha; <0.1 kg P/ha; 1.1 and 10.1 kg K/ha and 4.8 to 38.1 kg S/ha in the different treatments studied. The seed mix used contained oats as a nurse crop and 9 grass and 4 legume species. Plant growth was adequate to protect the soil surface from serious erosion. The dry weight production by the oats was considerably greater than for either the grasses or legumes. The cover produced by grasses and legumes alone would have been adequate in terms of erosion control except in those treatments involving heavy applications of mine overburdens. The dry weight production of root and shoot tissues was about the same. Root growth was largely restricted to the surface 15 cm. Total numbers of bacteria, fungi and actinomycetes as well as total soil respiration was considerably greater in soils from the revegetation experiments in comparison to samples of fresh or weathered tailings sand. (ERA citation 03:030334)

652691 IS-ICP-56
Water Quality Guidelines for Acid Mine Drainage and Strip Mine Areas in Iowa
Nesler, T. P. ; Bachmann, R. W.
Iowa State Univ. of Science and Technology, Ames. Energy and Mineral Resources Research Inst.
Corp. Source Codes: 9501363
Feb 77 179p
Document Type: Bibliography
NTIS Prices: PC A09/MF A01 Journal Announcement: GRAI7817 : NSA0300

Extensive literature compilation and investigation of state-of-the-art reclamation in four states contiguous to Iowa were conducted to review: the impact of coal mining upon water quality; the reclamation techniques utilized in countering the adverse effects of acid mine drainage; and the problems encountered in water quality management of strip-mined lands. Field analyses in strip-mine areas of Iowa have demonstrated similar degradation of water quality due to acid mine drainage. Distributions of alkalinity, specific conductance, sulfate and total iron in the streams with watersheds affected by mining were significantly different than those determined for the control streams, according to Chi-square analysis. The water quality is expected to worsen with expanding coal-mining activity unless effective reclamation accompanies this expansion. From the literature and based on the experience of other coal-mining states, certain techniques are considered essential in maintaining a suitable water quality in strip-mine areas. Segregation of acidic and nonacidic cast overburden, isolation and deep burial of spoil and mine wastes, hydrologic isolation of mine and coal processing areas, landscape stabilization through grading and revegetation, and cover or neutralization of abandoned strip-mine areas are the primary elements of successful regional reclamation and rehabilitation efforts. These efforts may be aided by premining analysis of mining impacts and planning of reclamation activity suitable to land use potential. Recommendations involving water quality regulations and further research necessary are provided. (ERA citation 03:030140)

650917 PB-280 625/5
Water Quality Management Guidance for Mine-Related Pollution Sources (New, Current, and Abandoned)
(Final rept.)
Deely, Dan
Environmental Protection Agency, Washington, D.C. Water Planning Div.
Report No.: EPA/440/3-77/027
Dec 77 212p
NTIS Prices: PC A10/MF A01 Journal Announcement: GRAI7816

Guidance information and direction is offered to State and local Water Quality Management (WQM) agencies dealing with prevention and control of water pollution from new, current and/or abandoned mine-related pollution sources under the U.S.

mine-related water Quality Management Plan development which are separately explained and discussed include water pollution source identification and assessment, current source control, identification and use of 'Best Management Practices', abandoned source abatement, new source planning, and continuing water quality planning and management. Information presented includes mining regulatory control system features needed for effective water pollution prevention and control, basic mining water pollution control principles, and distinctions between point sources and nonpoint sources. (Portions of this document are not fully legible)

650642 PB-280 169/4
Combination Limestone-Lime Neutralization of Ferrous Iron Acid Mine Drainage
(Final rept. Nov 75-Aug 76)
Wilmoth, Roger C.
Industrial Environmental Research Lab.-Cincinnati, Ohio. Resource Extraction and Handling Div.
Report No.: EPA/600/2-78/002
Jan 78 63p
NTIS Prices: PC A04/MF A01 Journal Announcement: GRAI7816

Studies were conducted on ferrous-iron acid mine drainage (AMD) treatment by a two-step neutralization process in which rock-dust limestone was mixed with the influent AMD and then hydrated lime was added in a polishing reactor. This combination treatment process resulted in reagent consumption cost reductions as high as 30 percent as compared to single-stage hydrated lime treatment of the same AMD. Later data indicated that an equal cost reduction (compared to single-stage lime treatment) could be achieved by a two-stage hydrated lime process in which the AMD and recycled sludge were mixed in the first reaction vessel and hydrated lime was added in the second reactor. No cost advantage for the combination process over straight hydrated lime treatment was felt to exist in situations where sludge recycling was not employed.

647326 UCRL-13803
Evaluation of Regional Effects of Effluents from Uranium Production in New Mexico
Wilson, D. W.
California Univ., Livermore. Lawrence Livermore Lab.
Corp. Source Codes: 9300007
Sponsor: Department of Energy.
4 Oct 77 13p
NTIS Prices: PC A02/MF A01 Journal Announcement: GRAI7815 ; NSA0300
Contract No.: W-7405-ENG-48

The Grants Uranium Region is a 2500 mile area of northcentral New Mexico which has produced about 40 percent of all domestic uranium, and holds over one-half of the current reserves. The increasing demand for uranium to fuel commercial nuclear power plants is resulting in rapid growth of the uranium industry and economic, social, and environmental changes are occurring. One of the environmental issues of this region is the concern for eventually unacceptable levels of air and water pollution from effluents from uranium mill tailings piles. This study addresses these potential impacts in relation to industrial environmental control practices, siting features, and other regional/temporal variables, including rates of production, locations and sizes of new mills, and population distributions. (ERA citation 03:025098)

646720 PB-279 321/4
Proceedings - Kentucky Coal Refuse Disposal and Utilization Seminar (3rd) Held at Lexington, Kentucky on May 11-12, 1977
Ross, Jerry G.
Kentucky Univ., Lexington. Inst. for Mining and Minerals Research.
Sponsor: Southeast Community Coll., Cumberland, Ky.
Report No.: IMMR32-M4-77
Dec 77 119p
See also report dated Sep 76, PB-262 645. Sponsored in part by Southeast Community Coll., Cumberland, Ky.
Document Type: Conference proceeding
NTIS Prices: PC A06/MF A01 Journal Announcement: GRAI7815

Contents: State-of-the-art of coal cleaning and recent developments in equipment and circuits; Some economic aspects of coal preparation; Problems related to coal preparation plant design and construction; Pressure filtration technology in the coal industry; Gob pile and slurry pond sediment beneficiation using the Otisca process; Fine coal refuse pelletizing; Processing of coal refuse for a second yield of steam coal; Processing plant for the reclamation of coal; Overview of MESA regulations for refuse piles and retaining dams; Lightweight aggregate as a construction material; The sintered lightweight aggregate industry; Sintered coal refuse as a construction aggregate; Sintered coal refuse as a growing medium for plants; Enterprise development--A financial resource and the Kentucky ARC program; Aluminum from coal wastes; Recovery of alumina from fly ash by high-temperature chlorination; The potential economics of the recovery of trace elements in coal refuse; The distribution of aluminum in shales associated with the major economic coal seams of eastern Kentucky; Sources of Canadian non-bauxite alumina.

645980 GJT-55
Summary of the Phase II, Title I Engineering Assessment of Inactive Uranium Mill Tailings, Tuba City Site, Tuba City, Arizona
Ford, Bacon and Davis Utah, Inc., Salt Lake City.
Corp. Source Codes: 9502722
Sponsor: Department of Energy.
31 Mar 77 51p
NTIS Prices: PC A04/MF A01 Journal Announcement: GRAI7815 ; NSA0300
Contract No.: EY-76-C-13-1658

An engineering assessment was performed of the problems resulting from the existence of radioactive uranium mill tailings at the Tuba City millsite in Arizona. Services include the preparation of topographic maps, the performance of core drillings and radiometric measurements sufficient to determine areas and volumes of tailings and other radium-contaminated materials, the evaluation of resulting radiation exposures of individuals residing nearby, the investigation of site hydrology and meteorology and the evaluation and costing of alternative corrective actions. Radon gas release from the tailings on the site constitutes the most significant environmental impact to the inhabited area near the site. (ERA citation 03:019762)

645979 GJT-19S
Summary of the Phase II, Title I Engineering Assessment of Inactive Uranium Mill Tailing, Riverton Site, Riverton, Wyoming
Ford, Bacon and Davis Utah, Inc., Salt Lake City.
Corp. Source Codes: 9502722
Sponsor: Department of Energy.
Dec 77 52p
NTIS Prices: PC A04/MF A01 Journal Announcement: GRAI7815
; NSA0300
Contract No.: EY-76-C-13-1658

An engineering assessment was performed of the problems resulting from the existence of radioactive uranium mill tailings at the Riverton, Wyoming site. The soil, water and other sample analyses; radiometric measurements to determine areas with radium-contaminated materials; the evaluation of resulting radiation exposures of individuals and nearby populations; the investigation of site geology, hydrology, and meteorology; and the evaluation and costing of alternative corrective actions. Radon gas release from the 900,000 tons of tailings at the Riverton site constitutes the main environmental impact. The two alternative actions presented are fencing and maintenance of the site and off-site remedial action, and decontamination of the millsite and ore storage areas and additional stabilization cover to a minimum of 2 ft. The cost estimates for the options are $460,000 and $1,140,000, respectively. Estimated costs for moving the tailings and all contaminated materials to unspecified sites 5 and 10 mi from the present location are $6,000,000 and $6,400,000, respectively. (ERA citation 03:025121)

645978 GJT-10
Phase II, Title I, Engineering Assessment of Inactive Uranium Mill Tailings, Riverton Site, Riverton, Wyoming
Ford, Bacon and Davis Utah, Inc., Salt Lake City.
Corp. Source Codes: 9502722
Sponsor: Department of Energy.
Dec 77 199p
NTIS Prices: PC A09/MF A01 Journal Announcement: GRAI7815
; NSA0300
Contract No.: EY-76-C-13-1658

An engineering assessment was performed of the problems resulting from the existence of radioactive uranium mill tailings at the Spook Site, Converse County, Wyoming. Services include the performance of core drillings, soil, water and other sample analyses, radiometric measurements to determine areas with radium-contaminated materials, the evaluation of resulting radiation exposures of individuals and nearby populations, the investigation of site geology, hydrology, and meteorology and the evaluation and costing of alternative corrective actions. Radon gas release from the 187,000 tons of tailings at the Spook Site constitutes the main environmental impact, which is negligible. The two alternative actions presented are better fencing of the site in its present state, and placing tailings and contaminated on-site materials and

2 ft of overburden materials. The cost estimates for the options are $81,000 and $142,000, respectively. (ERA citation 03:025125)

645977 GJT-17S
Summary of the Phase II, Title I Engineering Assessment of Inactive Uranium Mill Tailings, Lowman Site, Lowman, Idaho
Ford, Bacon and Davis Utah, Inc., Salt Lake City.
Corp. Source Codes: 9502722
Sponsor: Department of Energy.
Dec 77 44p
NTIS Prices: PC A03/MF A01 Journal Announcement: GRAI7815
; NSA0300
Contract No.: EY-76-C-13-1658

An engineering assessment was performed of the problems resulting from the existence of radioactive uranium sand residues at the Lowman, Idaho site. Services included the preparation of topographic maps, the performance of core drillings and radiometric measurements sufficient to determine areas and volumes of tailings and other radium-contaminated materials, the evaluation of resulting investigation of site hydrology and meteorology, and the evaluation and costing of alternative corrective actions. Radon gas release from the 90,000 tons of sand residues at the Lowman site constitutes the most significant environmental impact, although external gamma radiation is also a factor. The two alternative actions presented are dike construction, fencing, and maintenance; and consolidation of the piles, addition of a 2-ft-thick stabilization cover, and on-site cleanup. Both options include remedial action at off-site structures. Cost estimates for the two options are $393,000 and $590,000. (ERA citation 03:025120)

645976 GJT-17
Phase II, Title I Engineering Assessment of Radioactive Sands and Residues, Lowman Site, Lowman Idaho
Ford, Bacon and Davis Utah, Inc., Salt Lake City.
Corp. Source Codes: 9502722
Sponsor: Department of Energy.
Dec 77 132p
NTIS Prices: PC A07/MF A01 Journal Announcement: GRAI7815 ; NSA0300
Contract No.: EY-76-C-13-1658

An engineering assessment was performed of the problems resulting from the existence of radioactive uranium sand residues at the Lowman, Idaho, site. Services normally include the preparation of topographic maps, the performance of core drillings and radiometric measurements sufficient to determine areas and volumes of tailings and other radium-contaminated materials, the evaluation of resulting investigations of site hydrology and meteorology, and the evaluation and costing of alternative corrective actions. Radon gas release from the 90,000 tons of sand residues at the Lowman site constitutes the most significant environmental impact, although external gamma radiation is also a factor. The two alternative actions presented are dike construction, fencing, and maintenance (Option I); and consolidation of the piles, addition of a 2-ft-thick stabilization cover, and on-site cleanup (Option II). Both options include remedial action at off-site structures. Cost estimates for the two options are $393,000 and $690,000. (ERA citation 03:025119)

645975 GJT-165
Summary of the Phase II, Title I Engineering Assessment of Inactive Uranium Mill Tailings, Falls City Site, Falls City, Texas
Ford, Bacon and Davis Utah, Inc., Salt Lake City.
Corp. Source Codes: 9502722
Sponsor: Department of Energy.
Dec 77 51p
NTIS Prices: PC A04/MF A01 Journal Announcement: GRAI7815 ; NSA0300
Contract No.: EY-76-C-13-1658

An engineering assessment was performed of the problems resulting from the existence of radioactive uranium mill tailings at Falls City, Texas. Services included taking soil samples, the performance of radiometric measurements sufficient to determine areas and volumes of tailings and other radium-contaminated materials, the evaluation of resulting radiation exposures of individuals and nearby populations, the investigation of site hydrology and meteorology and the evaluation and costing of alternative corrective actions. Radon gas release from the 2.5 million tons of tailings at the Falls City site constitutes the most significant environmental impact. Windblown tailings, external gamma radiation and localized contamination of surface waters are other environmental effects. The two alternative remedial action options presented include on-site and off-site cleanup, fencing, and hydrological monitoring and, in addition, stabilization of pile 2 with 2 ft of cover material. The costs are $1.84 million and $2.45 million. (ERA citation 03:025118)

645974 GJT-16
Phase II, Title I Engineering Assessment of Inactive Uranium Mill Tailings, Falls City Site, Falls City, Texas
Ford, Bacon and Davis Utah, Inc., Salt Lake City.
Corp. Source Codes: 9502722
Sponsor: Department of Energy.
Dec 77 168p
NTIS Prices: PC A08/MF A01 Journal Announcement: GRAI7815 ; NSA0300
Contract No.: EY-76-C-13-1658

An engineering assessment was performed of the problems resulting from the existence of radioactive uranium mill tailings at Falls City, Texas. Services included taking soil samples, the performance of radiometric measurements sufficient to determine areas and volumes of tailings and other radium-contaminated materials, the evaluation of resulting radiation exposures of individuals and nearby populations, the investigation of site hydrology and meteorology and the evaluation and costing of alternative corrective actions. Radon gas release from the 2.5 million tons of tailings at the Falls City site constitutes the most significant environmental impact. Windblown tailings, external gamma radiation and localized contamination of surface waters are other environmental effects. The two alternative remedial action options presented include on-site and off-site cleanup, fencing, and hydrological monitoring, and in addition, stabilization of pile 2 with 2 ft of cover material. The costs are $1.84 million for Option I and $2.45 million for Option II. (ERA citation 03:025117)

645973 GJT-15S
Summary of the Phase II, Title I Engineering Assessment of Inactive Uranium Mill Tailings, Spook Site, Converse County, Wyoming
Ford, Bacon and Davis Utah, Inc., Salt Lake City.
Corp. Source Codes: 9502722
Sponsor: Department of Energy.
Dec 77 48p
NTIS Prices: PC A03/MF A01 Journal Announcement: GRAI7815 ; NSA0300
Contract No.: EY-76-C-13-1658

An engineering assessment was performed of the problems resulting from the existence of radioactive uranium mill tailings at the Riverton, Wyoming site. The services include: the performance of core drillings; soil, water and other sample analyses; radiometric measurements to determine areas with radium-contaminated materials; the evaluation of resulting radiation exposures of individuals and nearby populations; the investigation of site geology, hydrology, and meteorology; and the evaluation and costing of alternative corrective actions. Radon gas release from the 900,000 tons of tailings at the Riverton site constitutes the main environmental impact. The two alternative actions presented are fencing and maintenance of the site and off-site remedial action and decontamination of the millsite and ore storage areas and additional stabilization cover to a minimum of 2 ft. The cost estimates for the options are $460,000 and $1,140,000, respectively. Estimated costs for moving the tailings and all contaminated materials to unspecified sites 5 and 10 mi from the present location are $6,000,000 and $6,400,000, respectively. (ERA citation 03:025124)

645972 GJT-15
Engineering Assessment of Inactive Uranium Mill Tailings, Spook Site, Converse County, Wyoming. Phase II, Title I
Ford, Bacon and Davis Utah, Inc., Salt Lake City.
Corp. Source Codes: 9502722
Sponsor: Department of Energy.
Dec 77 142p
NTIS Prices: PC A07/MF A01 Journal Announcement: GRAI7815 ; NSA0300
Contract No.: EY-76-C-13-1658

An engineering assessment of the problems resulting from the existence of radioactive uranium mill tailings was performed at the Spook Site, Converse County, Wyoming. Data are presented from soil, water and other sample analyses, radiometric measurements to determine areas with radium-contaminated materials, the evaluation of resulting radiation exposures of individuals and nearby populations, the investigation of site geology, hydrology, and meteorology, and the evaluation and costing of alternative corrective actions. Radon gas release from the 187,000 tons of tailings at the Spook Site constitutes the main environmental impact, which is negligible. The two alternative actions presented are better fencing of the site in its present state and placing tailings and contaminated on-site materials and soil in the open-pit mine and covering the resulting pile with 2 ft of overburden material. The cost estimates for the options are $81,000 and $142,000, respectively. Reprocessing the tailings for uranium at a nearby operating uranium mill is worthy of economic consideration at this time. (ERA citation 03:025116)

645971 GJT-14S
Summary of the Phase II, Title I Engineering Assessment of Inactive Uranium Mill Tailings, Green River Site, Green River, Utah
Ford, Bacon and Davis Utah, Inc., Salt Lake City.
Corp. Source Codes: 9502722
Sponsor: Department of Energy.
Dec 77 48p
NTIS Prices: PC A03/MF A01 Journal Announcement: GRAI7815 ; NSA0300
Contract No.: EY-76-C-13-1658

An engineering assessment was performed of the problems resulting from the existence of radioactive uranium mill tailings at the Green River site, Utah. The services include the preparation of topographic maps, the performance of core drillings and radiometric measurements sufficient to determine areas and volumes of tailings and other radium-contaminated materials, the evaluation of resulting radiation exposures of individuals and nearby populations, the investigation of site hydrology and meteorology and the evaluation and costing of alternative corrective actions. Radon gas release from the 123 thousand tons of tailings at the Green River site constitutes the most significant environmental impact, although windblown tailings and external gamma radiation are also factors. The three alternative actions presented are dike stabilization, fencing, on- and off-site decontamination and maintenance; improvements in the stabilization cover and diking plus cleanup of the site and Browns Wash, and realignment of Browns Wash; and addition of stabilization cover to a total of 2 ft, realignment of Browns Wash and placement of additional riprap, on-site cleanup and drainage improvements. All options include remedial action at off-site structures. Cost estimates for the three options range from $700,000 to $926,000. (ERA citation 03:025123)

645970 GJT-14
Phase II, Title I Engineering Assessment of Inactive Uranium Mill Tailings, Green River Site, Green River, Utah
Ford, Bacon and Davis Utah, Inc., Salt Lake City.
Corp. Source Codes: 9502722
Sponsor: Department of Energy.
Dec 77 133p
NTIS Prices: PC A08/MF A01 Journal Announcement: GRAI7815
; NSA0300
Contract No.: EY-76-C-13-1658

An engineering assessment was performed of the problems resulting from the existence of radioactive uranium mill tailings at the Green River site, Utah. Services included the preparation of topographic maps, the performance of core drillings and radiometric measurements sufficient to determine areas and volumes of tailings and other radium-contaminated materials, the evaluation of resulting radiation exposures of individuals and nearby populations , the investigation of site hydrology and meteorology and the evaluation and costing of alternative corrective actions. Radon gas release from the 123 thousand tons of tailings at the Green River site constitutes the most significant environmental impact, although windblown tailings and external gamma radiation are also factors. The three alternative actions presented are dike stabilization, fencing, on- and off-site decontamination and maintenance (Option I); improvements in the stabilization cover and diking plus cleanup of the site and Browns Wash, and realignment of Browns Wash (Option II); and addition of stabilization cover to a total of 2 ft, realignment of Browns Wash and placement of additional riprap, on-site cleanup and drainage improvements (Option III). All options include remedial action at off-site structures. Cost estimates for the three options range from $700,000 to $926,000. (ERA citation 03:025115)

645969 GJT-13S
Summary of the Phase II, Title I Engineering Assessment of Inactive Uranium Mill Tailings, Phillips/United Nuclear Site, Ambrosia Lake, New Mexico
Ford, Bacon and Davis Utah, Inc., Salt Lake City.
Corp. Source Codes: 9502722
Sponsor: Department of Energy.
Dec 77 49p
NTIS Prices: PC A03/MF A01 Journal Announcement: GRAI7815
; NSA0300
Contract No.: EY-76-C-13-1658

An engineering assessment was performed of the problems resulting from the existence of radioactive uranium mill tailings at the Phillips/United Nuclear site at Ambrosia Lake, New Mexico. Services included the preparation of topographic maps, the performance of core drillings sufficient to determine areas and volumes of tailings and radiometric measurements to determine radium-contaminated materials, the evaluation of resulting radiation exposures of individuals and nearby populations, the investigation of site hydrology and meteorology, and the evaluation and costing of alternative corrective actions. Radon gas release from the 2.6 million tons of tailings at the Phillips/United Nuclear site constitutes the most significant environmental impact, although windblown tailings and external gamma radiation are also factors. The estimated radiological health effects to the general population are considered to be minimal. The two alternative actions presented are: dike stabilization, fencing, and maintenance; and adding 2 ft of stabilization cover material. Both options include remedial action at off-site structures and on-site decontamination around the tailings pile. Cost estimates for the two options are $920,000 and $2,230,000, respectively. (ERA citation 03:025114)

645968 GJT-13
Phase II, Title I Engineering Assessment of Inactive Uranium Mill Tailings, Phillips/United Nuclear Site, Ambrosia Lake, New Mexico
Ford, Bacon and Davis Utah, Inc., Salt Lake City.
Corp. Source Codes: 9502722
Sponsor: Department of Energy.
Dec 77 151p
NTIS Prices: PC A08/MF A01 Journal Announcement: GRAI7815
; NSA0300
Contract No.: EY-76-C-13-1658

An engineering assessment was performed of the problems resulting from the existence of radioactive uranium mill tailings at the Phillips/United Nuclear site at Ambrosia Lake, New Mexico. Services included the preparation of topographic maps, the performance of core drillings sufficient to determine areas and volumes of tailings, and radiometric measurements to determine radium-contaminated materials, the evaluation of resulting radiation exposures of individuals and nearby populations, the investigation of site hydrology and meteorology, and the evaluation and costing of alternative corrective actions. Radon gas release from the 2.6 million tons of tailings at the Phillips/United Nuclear site constitutes the most significant environmental impact, although windblown tailings and external gamma radiation are also factors. The estimated radiological health effects to the general population are considered to be minimal. The two alternative actions presented are: dike stabilization, fencing, and maintenance; and adding 2 ft of stabilization cover material. Both options include remedial action at off-site structures and on-site decontamination around the tailings pile. Cost estimates for the two options are $920,000 and $2,230,000, respectively. (ERA citation 03:025113)

643594 GJT-125
Summary of the Phase II, Title I, Engineering Assessment of Inactive Uranium Mill Tailings, Gunnison Site, Gunnison, Colorado
Ford, Bacon and Davis Utah, Inc., Salt Lake City.
Corp. Source Codes: 9502722
Sponsor: Department of Energy.
Nov 77 56p
NTIS Prices: PC A04/MF A01 Journal Announcement: GRAI7814 ; NSA0300
Contract No.: EY-76-C-13-1658

Ford, Bacon and Davis Utah Inc. has performed an engineering assessment of the problems resulting from the existence of radioactive uranium mill tailings at Gunnison, Colorado. The Phase II--Title I services include the preparation of topographic measurements sufficient to determine areas and volumes of tailings and other radium-contaminated materials, the evaluation of resulting radiation exposures of individuals and nearby populations, the investigation of site hydrology and meteorology, and the evaluation and costing of alternative corrective actions. Radon gas release from the 0.5 million tons of tailings at the Gunnison site constitutes the most significant environmental impact, although windblown tailings and external gamma radiation are also factors. The nine alternative actions presented range from millsite decontamination (Option I), to adding various depths of stabilization cover material (Options II and III), to removal of the tailings to long-term storage sites and decontamination of the present site (Options IV through IX). Cost estimates for the nine options range from $480,000 to $5,890,000. Reprocessing the tailings for uranium does not appear to be economically attractive at present. (ERA citation 03:021201)

643175 CONF-7710101-4
Environmental Control Technology Program Studies at Argonne National Laboratory: Surface Mine Effluents
Bogner, J. E. ; Johnson, D. O.
Argonne National Lab., Ill.
Corp. Source Codes: 0448000
Sponsor: Department of Energy.
1977 10p
National conference on energy and the environment, Cincinnati, OH, USA, 31 Oct 1977.
Document Type: Conference proceeding
NTIS Prices: PC A02/MF A01 Journal Announcement: GRAI7814 ; NSA0300
Contract No.: W-31-109-ENG-38

The chemical quality of surface waters in areas characterized by coal strip mining is the result of both local and regional factors, including composition of coal, overburden, and underclay; mobility of selected chemical constituents in rocks, sediments, and minesoils; activity of chemoautotrophic bacteria; mining and reclamation methods and equipment; density of mining operations in a given watershed; seasonal fluctuations in regional stream discharges; and major problems associated with mine effluents in the eastern region are acid mine drainage, generated by the oxidation and subsequent hydrolysis of iron disulfide minerals, and high concentrations of dissolved metals and suspended solids. Control technologies commonly utilized to ameliorate these problems include (1) the addition of alkaline reagents such as hydrated lime, soda ash, or sodium hydroxide to neutralize the acid and promote the precipitation of dissolved metals; and (2) the construction of settling ponds to promote the sedimentation of suspended solids. (ERA citation 03:020911)

641054 PB-278 573/1
Iron
National Research Council, Washington, D.C. Committee on Medical and Biologic Effects of Environmental Pollutants.
Sponsor: Health Effects Research Lab., Research Triangle Park, N.C. Criteria and Special Studies Office.
Report No.: EPA/600/1-78/017
Feb 78 366p
NTIS Prices: PC A16/MF A01 Journal Announcement: GRAI7813
Contract No.: EPA-68-02-1226

The document surveys the effects of organic and inorganic iron that are relevant to humans and their environment. The biology and chemistry of iron are complex and only partially understood. Iron participates in oxidation reduction processes that not only affect its geochemical mobility, but also its entrance into biologic systems. Hydrated ferric oxide surfaces have adsorbent properties and may act as reaction sites and catalysts. In biologic systems, the iron atom is incorporated into several protein enzymes that participate in many oxygen and electron transport reactions. The report addresses the quantity and form of iron in the environment, its movement and the interaction between inorganic and organic forms of the metal. Some plants have capabilities of retrieving iron from the soil; vertebrates in general appear to be able to achieve satisfactory iron balance. Humans are the outstanding exception -- hundreds of millions of the world's peoples are iron-deficient because of inadequate amounts of available iron in the diet; deficiency may thus be the major iron-related environmental health problem faced by humans. Acute iron toxicity has been reported, but only with the ingestion of large amounts of iron salts.

640010 GJT-12

Engineering Assessment of Inactive Uranium Mill Tailings, Gunnison Site, Gunnison, Colorado. Phase II, Title I

Ford, Bacon and Davis Utah, Inc., Salt Lake City.
Corp. Source Codes: 9502722
Sponsor: Department of Energy.
Nov 77 237p
NTIS Prices: PC A11/MF A01 Journal Announcement: GRAI7813
; NSA0300
Contract No.: EY-76-C-13-1658

Ford, Bacon and Davis Utah Inc. has performed an engineering assessment of the problems resulting from the existence of radioactive uranium mill tailings at Gunnison, Colorado. The Phase II - Title I services include the preparation of topographic measurements sufficient to determine areas and volumes of tailings and other radium-contaminated materials, the evaluation of resulting radiation exposures of individuals and nearby populations, the investigation of site hydrology and meteorology, and the evaluation and costing of alternative corrective actions. Radon gas release from the 0.5 million tons of tailings at the Gunnison site constitutes the most significant environmental impact, although windblown tailings and external gamma radiation are also factors. The nine alternative actions presented range from millsite decontamination (Option I), to adding various depths of stabilization cover material (Options II and III), to removal of the tailings to long-term storage sites and decontamination of the present site (Options IV through IX). Cost estimates for the nine options range from $400,000 to $5,890,000. Reprocessing the tailings for uranium does not appear to be economically attractive at present. (ERA citation 03:017001)

640009 GJT-11S

Engineering Assessment of Inactive Uranium Mill Tailings, Maybell Site, Maybell, Colorado. Summary of the Phase II, Title I

Ford, Bacon and Davis Utah, Inc., Salt Lake City.
Corp. Source Codes: 9502722
Sponsor: Department of Energy.
Oct 77 52p
NTIS Prices: PC A04/MF A01 Journal Announcement: GRAI7813
; NSA0300
Contract No.: EY-76-C-13-1658

Ford, Bacon and Davis Utah Inc. has performed an engineering assessment of the problems resulting from the existence of radioactive uranium mill tailings at Maybell, Colorado. The Phase II-Title I services include the preparation of topographic maps, the performance of core drillings sufficient to determine areas and volumes of tailings and radiometric measurements to determine radium-contaminated materials, the evaluation of resulting radiation exposures of individuals and nearby populations, the investigation of site hydrology and meteorology and the evaluation and costing of alternative corrective actions. Radon gas release from the 2.6 million tons of tailings at the Maybell site constitutes the most significant environmental impact, although windblown tailings and external gamma radiation are also factors. The three alternative actions presented range from fencing and maintenance (Option I), to placing the tailings in an open-pit mine and adding 2 ft of stabilization cover material (Option III). Cost estimates for the three options range from $250,000 to $4,520,000. Reprocessing the tailings for uranium does not appear to be economically attractive at present. (ERA citation 03:017000)

640008 GJT-11

Engineering Assessment of Inactive Uranium Mill Tailings, Maybell Site, Maybell, Colorado. Phase II, Title I

Ford, Bacon and Davis Utah, Inc., Salt Lake City.
Corp. Source Codes: 9502722
Sponsor: Department of Energy.
Oct 77 258p
NTIS Prices: PC A12/MF A01 Journal Announcement: GRAI7813
; NSA0300
Contract No.: EY-76-C-3-1658

Ford, Bacon and Davis Utah Inc. has performed an engineering assessment of the problems resulting from the existence of radioactive uranium mill tailings at Maybell, Colorado. The Phase II--Title I services include the preparation of topographic maps, the performance of core drillings sufficient to determine areas and volumes of tailings and radiometric measurements to determine radium-contaminated materials, the evaluation of resulting radiation exposures of individuals and nearby populations, the investigation of site hydrology and meteorology and the evaluation and costing of alternative corrective actions. Radon gas release from the 2.6 million tons of tailings at the Maybell site constitutes the most significant environmental impact, although windblown tailings and external gamma radiation are also factors. The three alternative actions presented range from fencing and maintenance (Option I), to placing the tailings in an open-pit mine and adding 2 ft of stabilization cover material (Option III). Cost estimates for the three options range from $250,000 to $4,520,000. Reprocessing the tailings for uranium does not appear to be economically attractive at present. (ERA citation 03:016999)

640006 GJT-10
Engineering Assessment of Inactive Uranium Mill Tailings New and Old Rifle Site, Rifle, Colorado. Phase II, Title I
Ford, Bacon and Davis Utah, Inc., Salt Lake City.
Corp. Source Codes: 9502722
Sponsor: Department of Energy.
Oct 77 234p
NTIS Prices: PC A11/MF A01 Journal Announcement: GRAI7813 ; NSA0300
Contract No.: EY-76-C-13-1658

Ford, Bacon and Davis Utah Inc. has performed an engineering assessment of the problems resulting from the existence of radioactive uranium mill tailings at Rifle, Colorado. The Phase II--Title I services include the preparation of topographic maps, the performance of core drillings and radiometric measurements sufficient to determine areas and volumes of tailings and other radium-contaminated materials, the evaluation of resulting radiation exposures of individuals and nearby populations, the investigation of site hydrology and meteorology and the evaluation and costing of alternative corrective actions. Radon gas release from the 3.1 million tons of tailings at the two Rifle sites, constitutes the most significant environmental impact. Windblown tailings, external gamma radiation and localized contamination of surface waters are other environmental effects. The 15 alternative remedial action options presented range from millsite decontamination and off-site remedial action (Options I and IV), to adding various depths of stabilization cover material (Options II, V, VI and VII), to removal of the tailings to long-term storage sites and decontamination of the present sites (Options III and VIII through XV). Cost estimates for the first 14 options range from $224,000 to $20,300,000. Option XV, estimated at $32,200,000, includes the cost for moving both Rifle tailings piles and the Grand Junction tailings pile to DeBeque for long-term storage and site decontamination after removal of the piles. Reprocessing of the tailings for uranium appears to be economically attractive at present. (ERA citation 03:016997)

637997 PB-278 161/5
Soil as a Medium for the Renovation of Acid Mine Drainage Water: Part I. Soil-Water Quality and Vegetative Responses
(Completion rept.)
Ciolkosz, E. J. ; Kardos, L. T. ; Cronce, R. C. ; Stein, E. R.
Pennsylvania State Univ., University Park. Dept. of Agronomy.
Sponsor: Office of Water Research and Technology, Washington, D.C.
Report No.: W78-04704; OWRT-B-086-PA(1)(PT-1)
Jan 78 242p
NTIS Prices: PC A11/MF A01 Journal Announcement: GRAI7812
Contract No.: DI-14-34-0001-6114; OWRT-B-086-PA

water were studied. Acid water from a stream was applied weekly at three levels to an unlimed and a limed floodplain soil. Soil water samples were collected weekly. The soil water samples and the acid water applied were analyzed for pH, total acidity, conductivity, Al, Fe, Mn, SO4, Ca, Mg, K, and Na. Perennial ryegrass and tall fescue were planted in separate halves of each experimental unit. During the study, the grasses were measured for yield, height, stand density and percent cover. Both the unlimed and limed areas initially had considerable capacity for renovating the applied acid water. Liming and the weekly levels of acid water irrigation significantly affected the growth of perennial ryegrass and tall fescue.

632353 DOCKET-408452-1
Bear Creek Project. Final Environmental Statement
Nuclear Regulatory Commission, Washington, D.C. Office of Nuclear Material Safety and Safeguards.
Corp. Source Codes: 9502169
Jun 77 472p
NTIS Prices: PC A20/MF A01 Journal Announcement: GRAI7810 ; NSA0300

The Bear Creek Project consists of certain mining and milling operations involving uranium ore deposits located in Converse County, Wyoming. Mining of uranium from nine known ore bodies will take place over a period of ten years (estimated); a mill with a nominal capacity of 1000 tons per day of ore will be constructed and operated as long as ore is available. The waste material (tailings) from the mill, also produced at a rate of about 1000 tons per day, will be stored onsite in an impoundment. Environmental impacts and adverse effects are summarized. (ERA citation 03:011707)

631054 PB-276 599/8

Feasibility of Silver-Lead Mine Waste Manipulation for Mine Drainage Control

(Final rept. Mar 73-Mar 75)

Montana Dept. of Natural Resources and Conservation, Helena. Engineering Bureau.

Sponsor: Industrial Environmental Research Lab., Cincinnati, Ohio.

Report No.: EPA/600/2-77/225

Nov 77 109p

NTIS Prices: PC A06/MF A01 Journal Announcement: GRAI7809

Contract No.: EPA-S-802122

The purpose of the Feasibility Study Dry Fork of Belt Creek, Montana is to examine solutions and methods of abatement of acid mine drainage problems and recommend a solution. The Galena Creek area in the Dry Fork of Belt Creek drainage contains several old mine tailings piles from which acidic waters emerge. The acidic water has destroyed the aquatic life in Galena Creek and the Dry Fork of Belt Creek as well as ruined the overall aesthetic value of both creeks. Mine dump surface regrading and sealing are recommended as the method of reducing the acidic wastes entering Galena Creek. The top of Block P Mine dump should be sloped so as to allow proper drainage. The top should also be sealed with a bentonite seal, and top soil added to allow revegetation. The bypass pipeline around the Block P dump should be extended to prevent water in Galena Creek from creating seeps in the toe of the dump.

630189 GJT-95

Engineering Assessment of Inactive Uranium Mill Tailings, Grand Junction Site, Grand Junction, Colorado. A Summary of the Phase II, Title I

Ford, Bacon and Davis Utah, Inc., Salt Lake City.

Corp. Source Codes: 9502722

Sponsor: Energy Research and Development Administration.

Oct 77 57p

NTIS Prices: PC A04/MF A01 Journal Announcement: GRAI7809 ; NSA0300

Contract No.: EY-76-C-13-1658

Ford, Bacon and Davis Utah Inc. has performed an engineering assessment of the problems resulting from the existence of radioactive uranium mill tailings at Grand Junction, Colorado. The Phase II, Title I services include the preparation of topographic maps, the performance of core drillings and radiometric measurements sufficient to determine areas and volumes of tailings and radiation exposures of individuals and nearby populations, the investigation of site hydrology and meteorology, and the evaluation and costing of alternative corrective actions. Radon gas release from the 1.9 million tons of tailings at the Grand Junction site constitutes the most significant environmental impact, although windblown tailings and external gamma radiation are also factors. The eight alternative actions presented range from millsite decontamination (Option I), to adding various depths of stabilization cover material (Options II and III), to removal of the tailings to long-term storage sites and decontamination of the present site (Options IV through VIII). Cost estimates for the eight options range from $470,000 to $18,130,000. Reprocessing the tailings for uranium recovery does not appear to be economically attractive at present. (ERA citation 03:009833)

630188 GJT-9

Engineering Assessment of Inactive Uranium Mill Tailings, Grand Junction Site, Grand Junction, Colorado. Phase II, Title I

Ford, Bacon and Davis Utah, Inc., Salt Lake City.

Corp. Source Codes: 9502722

Sponsor: Energy Research and Development Administration.

Oct 77 196p

NTIS Prices: PC A09/MF A01 Journal Announcement: GRAI7809 ; NSA0300

Contract No.: EY-76-C-13-1658

Ford, Bacon and Davis Utah Inc. has performed an engineering assessment of the problems resulting from the existence of radioactive uranium mill tailings at Grand Junction, Colorado. The Phase II, Title I services include the preparation of topographic maps, the performance of core drillings and radiometric measurements sufficient to determine areas and volumes of tailings and radiation exposures of individuals and nearby populations, the investigation of site hydrology and meteorology and the evaluation and costing of alternative corrective actions. Radon gas release from the 1.9 million tons of tailings at the Grand Junction site constitutes the most significant environmental impact, although windblown tailings and external gamma radiation are also factors. The eight alternative actions presented range from millsite decontamination (Option I), to adding various depths of stabilization cover material (Options II and III), to removal of the tailings to long-term storage sites and decontamination of the present site (Options IV through VIII). Cost estimates for the eight options range from $470,000 to $18,130,000. Reprocessing the tailings for uranium recovery does not appear to be economically attractive at present. (ERA citation 03:009832)

630187 GJT-85
Engineering Assessment of Inactive Uranium Mill Tailings, Naturita Site, Naturita, Colorado. A Summary of the Phase II, Title I
Ford, Bacon and Davis Utah, Inc., Salt Lake City.
Corp. Source Codes: 9502722
Sponsor: Energy Research and Development Administration.
Nov 77 51p
NTIS Prices: PC A04/MF A01 Journal Announcement: GRAI7809
; NSA0300
Contract No.: EY-76-C-13-1658

Ford, Bacon and Davis Utah Inc. has performed an engineering assessment of the problems resulting from the existence of radioactive uranium mill tailings at Naturita, Colorado. The Phase II, Title I services include the preparation of topographic maps, the performance of core drillings sufficient to determine areas and volumes of tailings, the performance of radiometric measurements to determine the extent of radium contamination, the evaluation of resulting radiation exposures of individuals and nearby populations, the investigation of site hydrology and meteorology, and the costing of alternative corrective actions. Radon gas release from the 704,000 tons of tailings at the Naturita site constitutes the most significant environmental impact although windblown tailings and external gamma radiation are also factors. Ranchers Exploration and Development Company has been licensed by the State of Colorado to reprocess the tailings at a location 3 mi from the present site where they will be stabilized for long-term storage. The remedial action options include remedial action for structures in Naturita and Nucla (Option I) at an estimated cost of $270,000 and remedial action for structures and open land adjacent to the tailings site (Option II) at an estimated cost of $950,000. (ERA citation 03:009831)

630186 GJT-8
Engineering Assessment of Inactive Uranium Mill Tailings, Naturita Site, Naturita, Colorado. Phase II, Title I
Ford, Bacon and Davis Utah, Inc., Salt Lake City.
Corp. Source Codes: 9502722
Sponsor: Energy Research and Development Administration.
Nov 77 153p
NTIS Prices: PC A08/MF A01 Journal Announcement: GRAI7809
; NSA0300
Contract No.: EY-76-C-13-1658

Ford, Bacon and Davis Utah Inc. has performed an engineering assessment of the problems resulting from the existence of radioactive uranium mill tailings at Naturita, Colorado. The Phase II, Title I services include the preparation of topographic maps, the performance of core drillings sufficient to determine areas and volumes of tailings, the performance of radiometric measurements to determine the extent of radium contamination, the evaluation of resulting radiation exposures of individuals and nearby populations, the investigation of site hydrology and meteorology, and the costing of alternative corrective actions. Radon gas release from the 704,000 tons of tailings at the Naturita site constitutes the most significant environmental impact although windblown tailings and external gamma radiation are also factors. Ranchers Exploration and Development Company has been licensed by the State of Colorado to reprocess the tailings at a location 3 mi from the present site where they will be stabilized for long-term storage. The remedial action options include remedial action for structures in Naturita and Nucla (Option I) at an estimated cost of $270,000 and remedial action for structures and open land adjacent to the tailings site (Option II) at an estimated cost of $950,000. (ERA citation 03:009830)

630185 GJT-75
Engineering Assessment of Inactive Uranium Mill Tailings, Slick Rock Sites, Slick Rock, Colorado. A Summary of the Phase II, Title I
Ford, Bacon and Davis Utah, Inc., Salt Lake City.
Corp. Source Codes: 9502722
Sponsor: Energy Research and Development Administration.
Oct 77 58p
NTIS Prices: PC A04/MF A01 Journal Announcement: GRAI7809
; NSA0300
Contract No.: EY-76-C-13-1658

Ford, Bacon and Davis Utah Inc. has performed an engineering assessment of the problems resulting from the existence of radioactive uranium mill tailings at the two millsites in Slick Rock, Colorado. The Phase II, Title I services include the preparation of topographic maps, the performance of core drillings and radiometric measurements sufficient to determine areas and volumes of tailings and other radium-contaminated materials, the evaluation of resulting radiation exposures of individuals residing nearby, the investigation of site hydrology and meteorology, and the evaluation and costing of alternative corrective actions. The Union Carbide site has 350,000 tons of tailings and the North Continent site now owned by Union Carbide has 37,000 tons of tailings. Both tailings piles have been stabilized in accordance with regulations of the State of Colorado. Radon gas release from the tailings on the sites constitute the most significant environmental impact, although windblown tailings and external gamma radiation are also factors. The sparse population and relatively low radiation levels yield minimal immediate environmental impact. Hence the three alternative actions presented are directed towards restricting access to the sites (Option I), and returning the windblown tailings to the piles and stabilizing the piles with cover material (Option II), and consolidating the two piles on the UC site and stabilizing with 2 ft of cover (Option III). Fencing around the tailings piles is included in all options. Options II and III provide 2 ft of cover material on the tailings. Costs of the options range from $370,000 to $1,100,000. Reprocessing the tailings for uranium is not economically feasible. (ERA citation 03:009829)

630184 GJT-7
Engineering Assessment of Inactive Uranium Mill Tailings, Slick Rock Sites, Slick Rock, Colorado. Phase II, Title I
Ford, Bacon and Davis Utah, Inc., Salt Lake City.
Corp. Source Codes: 9502722
Sponsor: Energy Research and Development Administration.
Oct 77 196p
NTIS Prices: PC A09/MF A01 Journal Announcement: GRAI7809
; NSA0300
Contract No.: EY-76-C-13-1658

Ford, Bacon and Davis Utah Inc. has performed an engineering assessment of the problems resulting from the existence of radioactive uranium mill tailings at the two millsites in Slick Rock, Colorado. The Phase II, Title I services include the preparation of topographic maps, the performance of core drillings and radiometric measurements sufficient to determine areas and volumes of tailings and other radium-contaminated materials, the evaluation of resulting radiation exposures of individuals residing nearby, the investigation of site hydrology and meteorology, and the evaluation and costing of alternative corrective actions. The Union Carbide site has 350,000 tons of tailings and the North Continent site now owned by Union Carbide has 37,000 tons of tailings. Both tailings piles have been stabilized in accordance with regulations of the State of Colorado. Radon gas release from the tailings on the sites constitute the most significant environmental impact, although windblown tailings and external gamma radiation are also factors. The sparse population and relatively low radiation levels yield minimal immediate environmental impact. Hence the three alternative actions presented are directed towards restricting access to the sites (Option I), and returning the windblown tailings to the piles and stabilizing the piles with cover material (Option II), and consolidating the two piles on the UC site and stabilizing with 2 ft of cover (Option III). Fencing around the tailings piles is included in all options. Options II and III provide 2 ft of cover material on the tailings. Costs of the options range from $370,000 to $1,100,000. Reprocessing the tailings for uranium is not economically feasible. (ERA citation 03:009828)

630183 GJT-65
Engineering Assessment of Inactive Uranium Mill Tailings, Durango Site, Durango, Colorado. A Summary of the Phase II, Title I
Ford, Bacon and Davis Utah, Inc., Salt Lake City.
Corp. Source Codes: 9502722
Sponsor: Energy Research and Development Administration.
Nov 77 56p
NTIS Prices: PC A04/MF A01 Journal Announcement: GRAI7809 : NSA0300
Contract No.: EY-76-C-13-1658

Ford, Bacon and Davis Utah Inc. has performed an engineering assessment of the problems resulting from the existence of radioactive uranium mill tailings at Durango, Colorado. The Phase II, Title I services include the preparation of topographic maps, the performance of core drillings and radiometric measurements sufficient to determine areas and volumes of tailings and other radium-contaminated materials, the evaluation of resulting radiation exposures of individuals and nearby populations, the investigation of site hydrology and meteorology and the evaluation and costing of alternative corrective actions. Radon gas release from the 1.555 million tons of tailings at the Durango site constitutes the most significant environmental impact, although windblown tailings and external gamma radiation are also factors. The eight alternative actions presented range from vegetative stabilization (Option I), to contouring and stabilizing in-place with varying depths of cover material (Options II and III), to removal to an isolated long-term disposal site (Options V to VIII). All options include remedial action costs for offsite locations where tailings have been placed. Costs estimated for the eight options range from $4,340,000 to $13,590,000. Reprocessing the tailings for uranium is sufficiently economically attractive to justify reprocessing in conjunction with each of the options. (ERA citation 03:009827)

630182 GJT-6
Engineering Assessment of Inactive Uranium Mill Tailings, Durango Site, Durango, Colorado. Phase II, Title I
Ford, Bacon and Davis Utah, Inc., Salt Lake City.
Corp. Source Codes: 9502722
Sponsor: Energy Research and Development Administration.
Nov 77 202p
NTIS Prices: PC A10/MF A01 Journal Announcement: GRAI7809 : NSA0300
Contract No.: EY-76-C-13-1658

Ford, Bacon and Davis Utah Inc. has performed an engineering assessment of the problems resulting from the existence of radioactive uranium mill tailings at Durango, Colorado. The Phase II, Title I services include the preparation of topographic maps, the performance of core drillings and radiometric measurements sufficient to determine areas and volumes of tailings and other radium-contaminated materials, the evaluation of resulting radiation exposures of individuals and nearby populations, the investigation of site hydrology and meteorology and the evaluation and costing of alternative corrective actions. Radon gas release from the 1.555 million tons of tailings at the Durango site constitutes the most significant environmental impact, although windblown tailings and external gamma radiation are also factors. The eight alternative actions presented range from vegetative stabilization (Option I), to contouring and stabilizing in-place with varying depths of cover material (Options II and III), to removal to an isolated long-term disposal site (Options V to VIII). All options include remedial action costs for offsite locations where tailings have been placed. Costs estimated for the eight options range from $4,340,000 to $13,590,000. Reprocessing the tailings for uranium is sufficiently economically attractive to justify reprocessing in conjunction with each of the options. (ERA citation 03:009826)

630181 GJT-5

Engineering Assessment of Inactive Uranium Mill Tailings, Tuba City Site, Tuba City, Arizona. Phase II, Title I

Ford, Bacon and Davis Utah, Inc., Salt Lake City.
Corp. Source Codes: 9502722
Sponsor: Energy Research and Development Administration.
31 Mar 77 175p
NTIS Prices: PC A08/MF A01 Journal Announcement: GRAI7809
; NSA0300
Contract No.: EY-76-C-13-1658

Ford, Bacon and Davis Utah Inc. has performed an engineering assessment of the problems resulting from the existence of radioactive uranium mill tailings at the Tuba City millsite in Arizona. The Phase II, Title I services include the preparation of topographic maps, the performance of core drillings and radiometric measurements sufficient to determine areas and volumes of tailings and other radium-contaminated materials, the evaluation of resulting radiation exposures of individuals residing nearby, the investigation of site hydrology and meteorology and the evaluation and costing of alternative corrective actions. Radon gas release from the tailings on the site constitutes the most significant environmental impact to the inhabited area near the site. In the downwind direction, to the northeast of the site, airborne radioactivity is greater than Federal guidelines but there are no dwellings in that direction in the area of concern. Gamma radiation is significant over the tailings but is near background levels in the housing area. The sparse population and relatively low radiation levels yield minimal immediate environmental impact; hence, the four alternative actions presented are directed towards restricting access to the site (Option I), and returning the windblown tailings to the pile and stabilizing the pile with cover material (Options II, III, and IV). Fencing around the site or the tailings pile and the removal or decontamination of mill buildings is included in all options. Option II provides 2 ft of cover material on the tailings, Option III provides 4 ft of cover, and Option IV provides 13 ft of cover. Costs of the options range from $671,000 to $2,904,000. Reprocessing the tailings for uranium is only marginally feasible and would require a more detailed economic evaluation before any action was taken. (ERA citation 03:009825)

630180 GJT-4S

Engineering Assessment of Inactive Uranium Mill Tailings, Monument Valley Site, Monument Valley, Arizona. A Summary of the Phase II, Title I

Ford, Bacon and Davis Utah, Inc., Salt Lake City.
Corp. Source Codes: 9502722
Sponsor: Energy Research and Development Administration.
31 Mar 77 50p
NTIS Prices: PC A03/MF A01 Journal Announcement: GRAI7809
; NSA0300
Contract No.: EY-76-C-13-1658

Ford, Bacon and Davis Utah Inc. has performed an engineering assessment of the problems resulting from the existence of radioactive uranium mill tailings at the Monument Valley millsite in Arizona. The Phase II, Title I services include the preparation of topographic maps, the performrance of core drillings and radiometric measurements sufficient to determine areas and volumes of tailings and other radium-contaminated materials, the evaluation of resulting radiation exposures of individuals residing nearby, the investigation of site hydrology and meteorology and the evaluation and costing of alternative corrective actions. Radon gas release from the tailings on the site constitutes the most significant environmental impact, although windblown tailings and external gamma radiation are also factors. The sparse population and relatively low radiation levels yield minimal immediate environmental impact; hence, the two alternative actions presented are directed towards restricting access to the site (Options I and II), and returning the windblown tailings to the pile and stabilizing the pile with 2 ft of cover material (Option II). Both options include remedial action costs for offsite locations where tailings have been placed. Cost estimates for the two options are $585,000 and $1,165,000. Reprocessing the tailings for uranium is not economically feasible. (ERA citation 03:009824)

630179 GJT-4
Phase II, Title I Engineering Assessment of Inactive Uranium Mill Tailings, Monument Valley Site, Monument Valley, Arizona
Ford, Bacon and Davis Utah, Inc., Salt Lake City.
Corp. Source Codes: 9502722
Sponsor: Energy Research and Development Administration.
31 Mar 77 173p
NTIS Prices: PC A08/MF A01 Journal Announcement: GRAI7809
; NSA0300
Contract No.: EY-76-C-13-1658

An engineering assessment was made of the problems resulting from the existence of radioactive uranium mill tailings at the Monument Valley millsite in Arizona. The Phase II, Title I services include the preparation of topographic maps, the performance of core drillings and radiometric measurements sufficient to determine areas and volumes of tailings and other radium-contaminated materials, the evaluation of resulting radiation exposures of individuals residing nearby, the investigation of site hydrology and meteorology and the evaluation and costing of alternative corrective actions. Radon gas release from the tailings on the site constitutes the most significant environmental impact, although windblown tailings and external gamma radiation are also factors. The sparse population and relatively low radiation levels yield minimal immediate environmental impact; hence, the two alternative actions presented are directed towards restricting access to the site and returning the windblown tailings to the pile and stabilizing the pile. Both options include remedial action costs for offsite locations where tailings have been placed. Cost estimates for the two options are $585,000 and $1,165,000. (ERA citation 03:009777)

630178 GJT-35
Engineering Assessment of Inactive Uranium Mill Tailings, Mexican Hat Site, Mexican Hat, Utah. A Summary of the Phase II, Title I
Ford, Bacon and Davis Utah, Inc., Salt Lake City.
Corp. Source Codes: 9502722
Sponsor: Energy Research and Development Administration.
31 Mar 77 52p
NTIS Prices: PC A04/MF A01 Journal Announcement: GRAI7809
; NSA0300
Contract No.: EY-76-C-13-1658

Ford, Bacon and Davis Utah Inc. has performed an engineering assessment of the problems resulting from the existence of radioactive uranium mill tailings at the Mexican Hat millsite in Utah. The Phase II, Title I services include the preparation of topographic maps, the performance of core drillings and radiometric measurements sufficient to determine areas and volumes of tailings and other radium-contaminated materials, the evaluation of resulting radiation exposures of individuals residing nearby, the investigation of site hydrology and meteorology, and the evaluation and costing of alternative corrective actions. Radon gas release from the 2,200,000 tons of tailings on the site constitutes the most significant environmental impact. The six alternative actions presented are directed towards restricting access to the site (Option I), returning the windblown tailings to the piles and stabilizing the piles with cover material (Options II, III, and IV), and consolidating the two piles into one pile and stabilizing it with cover material (Options V and VI). Fencing around the site or the tailings and the decontamination of mill buildings is included in all options. Options II and V provide 2 ft of cover material on the tailings. Options III, IV, and VI provide 4 ft, 13 ft, and 10 ft of cover, respectively. Costs of the options range from $370,000 to $4,390,000. Reprocessing the tailings for uranium is not feasible at present. (ERA citation 03:009823)

630177 GJT-3
Phase II, Title I Engineering Assessment of Inactive Uranium Mill Tailings, Mexican Hat Site, Mexican Hat, Utah
Ford, Bacon and Davis Utah, Inc., Salt Lake City.
Corp. Source Codes: 9502722
Sponsor: Energy Research and Development Administration.
31 Mar 77 167p
NTIS Prices: PC A08/MF A01 Journal Announcement: GRAI7809
; NSA0300
Contract No.: EY-76-C-13-1658

An engineering assessment of the problems resulting from the existence of radioactive uranium mill tailings at the Mexican Hat millsite in Utah is presented. Topographic maps, data on core drillings and radiometric measurements sufficient to determine areas and volumes of tailings and other radium-contaminated materials, the evaluation of resulting radiation exposures of individuals residing nearby, the investigation of site hydrology and meteorology, and the evaluation and costing of alternative corrective actions are presented. Radon gas release from the 2,200,000 tons of tailings on the site constitutes the most significant environmental impact. T he six alternative actions presented are directed towards restricting access to the site, returning the windblown tailings to the piles and stabilizing the piles with cover material, and consolidating the two piles into one pile and stabilizing it with cover material. Fencing around the site or the tailings and the decontamination of mill buildings is included in all options. Costs of the options range from $370,000 to $4,390,000. (ERA citation 03:009776)

630176 GJT-2
Engineering Assessment of Inactive Uranium Mill Tailings, Shiprock Site, Shiprock, New Mexico. Phase II, Title I
Ford, Bacon and Davis Utah, Inc., Salt Lake City.
Corp. Source Codes: 9502722
Sponsor: Energy Research and Development Administration.
31 Mar 77 209p
NTIS Prices: PC A10/MF A01 Journal Announcement: GRAI7809 ; NSA0300
Contract No.: EY-76-C-13-1658

Ford, Bacon and Davis Utah Inc. has performed an engineering assessment of the problems resulting from the existence of radioactive uranium mill tailings at Shiprock, New Mexico. The Phase II, Title I services include the preparation of topographic maps, the performance of core drillings and radiometric measurements sufficient to determine areas and volumes of tailings and other radium-contaminated materials, the evaluation of resulting radiation exposures of individuals and nearby populations, the investigation of site hydrology and meteorology and the evaluation and costing of alternative corrective actions. Radon gas release from the 1.7 million tons of tailings at the Shiprock site constitutes the most significant environmental impact, although windblown tailings and external gamma radiation are also factors. The 11 alternative actions presented range from completion of the present ongoing EPA site decontamination plan (Option I), to stabilizing in-place with varying depths of cover material (Options II-IV), to removal to an isolated long-term disposal site (Options V-XI). All options include remedial action costs for off-site locations where tailings have been placed. Costs estimates for the 11 options range from $540,000 to $12,500,000. Reprocessing the tailings for uranium is not economically feasible. (ERA citation 03:009822)

626138 PB-275 560/1
Bioelectric Neutralization of Acid Waters
(Patent Application)
Sisler, Frederick D. ; Senftle, Frank E.
Department of the Interior, Washington, D.C.
Corp. Source Codes: 109950
Report No.: PAT-APPL-819 518; DOCKET/SUR-2559
Filed 26 Jul 77 17p

This Government-owned invention available for U.S. licensing and, possibly, for foreign licensing. Copy of application available NTIS.
Document Type: Patent
NTIS Prices: PC A02/MF A01 Journal Announcement: GRAI7807

The patent application provides a process for neutralizing acid-polluted water found in strip-mine lakes and in rivers which accept the acid effluent from manufacturing processes, and provides an apparatus suitable for the process. An apparatus is described for bioelectric neutralization of a body of water having a bottom of anaerobic mud and an acid supernatant liquid, the apparatus comprising a buoy riding on the surface of the water, an upper electrode preferably of carbon suspended from the buoy in the acid supernatant liquid, a lower electrode preferably of iron embedded in the anaerobic mud and a flexible, insulated electrical conductor preferably an insulated copper cable, conductively attached to the upper and lower electrodes. A plurality of sets of apparatus may be used spaced apart from each other in the body of water.

625788 NTIS/PS-78/0052/7
Coal Mine Waste (A Bibliography with Abstracts)
(Rept. for 1964-Jan 78)
Smith, Mona F.
National Technical Information Service, Springfield, Va.
Corp. Source Codes: 391812
Jan 78 143p
Supersedes NTIS/PS-77/0040, NTIS/PS-76/0053 and NTIS/PS-75/-112.
Document Type: Bibliography
NTIS Prices: PC N01/MF N01 Journal Announcement: GRAI7807

Research topics cover coal mining refuse, refuse dumps and spoil. Studies on disposal, utilization, environmental impacts and testing of these wastes are included, as are reports on land reclamation and spoil bank safety. (This updated bibliography contains 138 abstracts, 39 of which are new entries to the previous edition.)

625785 NTIS/PS-78/0049/3
Uranium Mining and Milling Environmental Studies (Citations from the Engineering Index Data Base)
(Rept. for 1970-77)
Smith, Mona F.
National Technical Information Service, Springfield, Va.
Corp. Source Codes: 391812
Jan 78 78p
See also NTIS/PS-78/0048.
Document Type: Bibliography
NTIS Prices: PC N01/MF N01 Journal Announcement: GRAI7807

Worldwide research is cited on uranium mining waste management and effluent control. Studies on mining practices, radon monitoring, health hazards, and land reclamation are covered. Government policies and regulations concerning present and long term waste handling are included. The nuclear fuel cycle from mining through spent fuel reprocessing is also discussed. (Containn 71 abstracts)

621749 PB-274 858/O
Design Guide for Metal and Nonmetal Tailings Disposal
(Information circular)
Soderberg, Roy L. ; Busch, Richard A.
Bureau of Mines, Spokane, Wash. Spokane Mining Research Center.
Corp. Source Codes: 390067
Sponsor: Gonzaga Univ., Spokane Wash. Dept. of Civil Engineering.
Report No.: BUMINES-IC-8755
1977 144p
Prepared by Gonzaga Univ., Spokane, Wash. Dept. of Civil Engineering.
NTIS Prices: PC A07/MF A01 Journal Announcement: GRAI7806

The Bureau of Mines has conducted considerable research on the design, construction, and operation of metal and nonmetal tailings ponds. This design guide and other related Bureau publications that preceded it are produced to assist the industry in the management of mill tailings disposal. It covers the site selection, sampling, laboratory testing, design, construction, operation and inspection of tailings embankments. The effects of environment, topography, and hydrogeology are also included. A review of various methods of stability analysis and factors affecting stability are presented. Because of the diversity of problems encountered in tailings embankments, specific solutions are not intended. The guide is, however, a useful checklist for designers, operators, and inspectors of this type of structure.

621516 PB-274 392/O
Effects of Abandoned Lead and Zinc Mines and Tailings Piles on Water Quality in the Joplin Area, Missouri
(Water-resource investigations (Final))
Geological Survey, Rolla, Mo. Water Resources Div.
Sponsor: Ozark Gateway Council of Governments, Joplin, Mo.
Report No.: USGS/WRD/WRI-77/079; USGS/WRI-77-75
Aug 77 55p
Prepared in cooperation with Ozark Gateway Council of Governments, Joplin, Mo.
NTIS Prices: PC A04/MF A01 Journal Announcement: GRAI7806

Dissolved zinc concentrations averaged 9,400 micrograms/liter in water from abandoned lead and zinc mines, some of which discharge at the surface. Contamination of the shallow aquifer (cherty limestones) by the highly mineralized mine water is limited to the immediate mining area. The quality of water in the deep aquifer (cherty dolomites and sandstone) is generally excellent. Dissolved zinc concentrations averaged 16,000 micrograms/liter in runoff from tailings areas. However, during a summer storm, runoff from a 7-acre tailings area contained maximum dissolved zinc, lead, and cadmium concentrations of 200,000; 400; and 1,400 micrograms/liter, respectively. Mine-water discharges increase dissolved zinc concentrations in receiving streams from a background of about 40 micrograms/liter to about 500 micrograms/liter during periods of low flow. The higher concentrations are sustained during high flow by runoff from the tailings areas. Deposition of tailings on stream bottoms increases zinc concentrations in bottom material from a background of about 100 micrograms/gram to about 2,500 micrograms/gram and increases lead concentrations in bottom material from about 20 micrograms/gram to about 450 micrograms/gram.

619009 LA-6839-MS
Geology and Hydrology in the Vicinity of the Inactive Uranium Mill Tailings Pile, Ambrosia Lake, New Mexico
Purtymun, W. D. ; Wienke, C. L. ; Dreesen, D. R.
Los Alamos Scientific Lab., N.Mex.
Corp. Source Codes: 3820000
Sponsor: Energy Research and Development Administration.
Jun 77 36p
NTIS Prices: PC A03/MF A01 Journal Announcement: GRAI7804 ; NSA0200
Contract No.: W-7405-ENG-36

A study was made of the geology and hydrology of the immediate area around a uranium mill at Ambrosia Lake, New Mexico. The mill was in operation from June 1958 through April 1963 and produced 2.7 x 10 exp 9 kg of tailings. The possible environmental consequences of this inactive tailings pile must first be delineated so that stabilization needs and future stabilization success can be properly assessed. The Ambrosia Lake area is underlain by over 1000 m of alternating shales, siltstones, and sandstones that dip gently to the northeast into the San Juan Basin. Water-bearing sandstones make up less than 25 percent of this sedimentary section. Water quality in the sandstones is fair to poor, with total dissolved solids ranging from 500 to 2000 mg/l. The present total volume of tailings is estimated at 1.5 x 10 exp 6 m exp 3 and ranges in thickness from about 1 to 10 m. The tailings pile is underlain by the Mancos shale which dips to the northeast. The shale is about 120 m thick with three interbedded silty sandstones that are about 9 m in thickness. One of these sandstones outcrops beneath the western part of the pile; the eastern part of the pile is underlain by shale. Ground water in the shales and sandstones beneath the pile is recharged by runoff north of the pile and from three ponds located north, northeast, and east of the pile. The movement of water in shale and sandstones is to the southwest. Secondary recharge to the water in the shales and sandstone is from the basin within the tailings pile. Water in the southeast part of the tailings basin is forming a ground water mound above the underlying sediments. The major transport mechanisms of tailings and possible contaminants from the pile include wind erosion, surface water runoff, movement of ground water beneath the pile, and gaseous diffusion from the pile. (ERA citation 02:055935)

617359 PB-273 559/5

Slippery Rock Creek Acid Mine Waste Studies for the Appalachian Regional Commission

(Final rept.)

Patrick, Ruth

Academy of Natural Sciences of Philadelphia, Pa. Div. of Limnology and Ecology.

Sponsor: Appalachian Regional Commission, Washington, D.C.

Report No.: ARC-68-24

Apr 74 139p

NTIS Prices: PC A07/MF A01 Journal Announcement: GRAI7803

Contract No.: ARC-68-24

The impact of coal mine drainage on aquatic flora and fauna in the Slippery Rock Creek near Butler, Pennsylvania was studied by a team of limnologists. The results show that acid mine wastes have a severe effect upon the aquatic ecosystems in streams and that this effect was mainly due to the low acidic pH created by the waste and the high amount of iron present. It was shown that intermittent discharges of acid mine wastes, wherein the stream waters return to a pH above 6, do not have nearly as severe an effect as when the waste is continual. If corrective measures are to be taken and become effective, the pH should be maintained at a level above 6 and floc due to the precipitation of iron should be retained in a basin and not allowed to enter the stream proper.

615533 PB-272 760/0

Soda Ash Treatment of Neutralized Mine Drainage

(Final rept. Jun 70-Dec 75)

Long, David A. ; Butler, James L. ; Lenkevich, Michael J.

Gwin, Dobson, and Foreman, Inc., Altoona, Pa.

Sponsor: Pennsylvania Dept. of Environmental Resources, Harrisburg.; Industrial Environmental Research Lab. Cincinnati, Ohio.

Report No.: EPA/600/2-77/090

May 77 76p

NTIS Prices: PC A05/MF A01 Journal Announcement: GRAI7802

Contract No.: EPA-14010-ELB

Utilization of acid mine drainage (AMD) streams as a source of potable and industrial water has become a major goal of several proposed AMD treatment schemes. From among the various schemes available, the lime neutralization/soda ash softening process was selected for use at Altoona, Pennsylvania. The treatment plant, as constructed, has the capability of treating waters from Kittanning Run (acid mine polluted) alone or in combination with waters from other city sources to achieve: (1) neutralization and iron removal to levels satisfactory for stream release, (2) softening to approximately 100 mg/l CaCO3 hardness for municipal use, and (3) softening to a hardness of 200 mg/l CaCO3 or higher to meet industrial use requirements. The objective of this study was to evaluate the technical and economic feasibility of softening neutralized AMD waters by means of the cold lime/soda ash process. The study was conducted full-scale at the Altoona Treatment Plant located near the Horseshoe Curve area of Altoona, Pennsylvania. Unit processes employed at the plant consisted of lime neutralization, aeration, settling, soda ash softening, recarbonation, and filtration.

615185 NTIS/PS-77/0949/6

Acid Mine Drainage (A Bibliography with Abstracts)

(Rept. for 1964-Nov 77)

Brown, Robena J.

National Technical Information Service, Springfield, Va.

Corp. Source Codes: 391812

Nov 77 225p

Supersedes NTIS/PS-77/0816, NTIS/PS-75/714, and NTIS/PS-75/046.

Document Type: Bibliography

NTIS Prices: PC N01/MF N01 Journal Announcement: GRAI7802

The bibliography on acid mine drainage cites studies primarily concerning control and treatment methods. Reports on hydrogeology, ecology, formation, and sources are included. (This updated bibliography contains 220 abstracts, 36 of which are new entries to the previous edition.)

615182 NP-22029

Reclamation and Vegetation of Surface Mined Areas in the Athabasca Tar Sands. Environmental Research Monograph 1977-1

Takyi, S. K. ; Rowell, M. H. ; McGill, W. B. ; Nyborg, M.

Alberta Univ., Edmonton. Dept. of Soil Science.

Corp. Source Codes: 0185800

1977 180p

U.S. Sales Only.

NTIS Prices: PC A09/MF A01 Journal Announcement: GRAI7802 ; NSA0200

This report deals with an experiment carried out on a dike on Great Canadian Oil Sands Ltd.'s Lease, and with experiments performed in a growth chamber. The experiment on the tailings pond dike was conducted to determine responses of the established vegetative cover to different fertility levels and to determine the fate of added fertilizer nutrients. The materials used in the various soil mixes were characterized chemically and biologically. In the growth chamber experiments, a number of plant species, both cultivated and native, were grown on the waste materials to determine the performance of each species under different salinity, soil reaction, fertility, soil mix, and oil conditions. Tentative recommendations are given for vegetating oil-sand areas. 56 tables, 8 figs. (ERA citation 02:047653)

613538 PB-272 921/8
Bureau of Mines Research on Resource Recovery. Reclamation, Utilization, Disposal, and Stabilization
(Information circular)
Spendlove, Max J.
Bureau of Mines, College Park, Md. College Park Metallurgy Research Center.
Report No.: BUMINES-8750
1977 112p
See also report dated Jul 75, PB-244 780.
NTIS Prices: PC A06/MF A01 Journal Announcement: GRAI7801

This report reviews in annotated form, the Bureau of Mines research and related studies in the fields of resource recovery, land restoration, reclamation and stabilization, and utilization and/or disposal of post-consumer goods and industrial wastes. Numerous typical examples of research are discussed in each sector of the U.S. materials supply--utilization--disposal system. Included are raw materials extraction, raw material beneficiation, bulk materials processing manufacturing, secondary materials, and post-consumer materials utilization and disposal. Discussions are supported with appropriate charts, tables, diagrams, and photographic illustrations. Each section includes extensive lists of other related references.

609547 PB-272 639/6
Heavy Metal Pollution from Spillage at Ore Smelters and Mills
(Final rept. Jun 72-Oct 74)
Calspan Corp., Buffalo, N.Y. Environmental Systems Dept.
Corp. Source Codes: 406460
Sponsor: Industrial Environmental Research Lab.-Cincinnati, Ohio.
Report No.: CALSPAN-ND-5189-M-1; EPA/600/2-77/171
Aug 77 128p
NTIS Prices: PC A06/MF A01 Journal Announcement: GRAI7726
Contract No.: EPA-68-01-0726

Smelter and mill wastewater outfalls, receiving water, biota, slag heaps, tailings ponds, streams, and coal-burning fly ash dumps were sampled as part of this effort to determine the effect of effluent or residual spillage on aquatic systems. Up to 17% lead, 0.1% cadmium and 5 ppm thallium were found in sediments of streams used for irrigation and drinking water below copper and zinc extractive industries in high runoff regions. Groundwater infiltration in the Northwest and Ozarks provides mine drainage water which is used as process water in mills. This water transports potentially toxic wastes into naturally erosive bottom sediments thereby contaminating the food chain. Prevention techniques recommended here include separation of waste streams, protection of tailing dams from flood erosion, and recycle of mill and smelter wastewater. Excess water discharged can be treated with lime at elevated pH to precipitate heavy metals and to prevent leaching of sediment already in streams.

608028 IS-ICP-41
Bryophytes and Revegetation of Coal Spoils in Southern Iowa
Carvey, K. ; Farrar, D. R. ; Glenn-Lewin, D. C.
Iowa State Univ. of Science and Technology, Ames. Energy and Mineral Resources Research Inst.
Corp. Source Codes: 9501363
1976 19p
NTIS Prices: PC A02/MF A01 Journal Announcement: GRAI7725 ; NSA0200

Strip mining of coal in southern Iowa has left many scattered areas of coal spoils which provide a type of habitat unique to the region. The occurrence and distribution of 29 mosses and 2 liverworts on these spoils was determined and related to the general process of spoil revegetation. The spoil bryophyte flora was compared with Conard's (1956) list of bryophytes for the region. An increase in per cent cover and in species diversity of bryophytes was observed with increasing age of spoils, and was correlated with increased vascular plant cover. Dicranella heteromalla and Ceratodon purpureus were found to be common throughout the spoils, whereas all other species were limited to more protected sites, especially on north-facing slopes. Mosses did not appear to colonize very exposed areas on the spoils, but were limited to areas with some protection provided, especially by vascular plants. Several disjunct or highly localized moss populations were found including one new state record and thirteen new county records. (ERA citation 02:042408)

607901 BM-RI-8216
Physical Properties of Western Coal Waste Materials
Backer, R. R. ; Busch, R. A. ; Atkins, L. A.
Bureau of Mines, Spokane, Wash. Spokane Mining Research Center.
Corp. Source Codes: 9500446
Sponsor: Energy Research and Development Administration.
1977 33p
NTIS Prices: PC A03/MF A01 Journal Announcement: GRAI7725 ; NSA0200

The Bureau of Mines investigated the typical physical and chemical properties of coal waste materials from the western part of the United States. The results are compared, in so far as possible, with the properties of waste materials from eastern coal operations. The authors found a disparity of mines and preparation plants among western U.S. coal operations and dissimilarities with typical operations in the East. The relatively cleaner product from the predominance of surface mining and the occurrence of thicker seams in the West reduces the amount of coal preparation required and the size of the waste piles. Because of the abundance of land available for waste disposal, many of the piles are low and extended over large areas. New concepts relating statistical shear strength data to liquefaction potential are presented. The somewhat limited data indicates that western coal sludge is coarser with higher permeabilities and shear strengths than the eastern deposits. (ERA citation 02:042398)

605197 PB-271 527/4
Water and Related Problems in Coal-Mine Areas of Alabama
(Water-resources investigations (Interim))
Knight, Alfred L. ; Newton, J. G.
Geological Survey, University, Ala. Water Resources Div.
Report No.: USGS/WRI-76-130; USGS/WRD/WRI-77/051
Apr 77 58p
NTIS Prices: PC A04/MF A01 Journal Announcement: GRAI7724

Water-resource problems or potential problems in Alabama resulting from surface and subsurface coal mining include erosion and sedimentation, flooding, diversion of drainage, decline in water level, land subsidence, and the degradation of water quality. The degradation of water quality is the most serious and widespread coal-mine related problem in Alabama. The chemical quality of water in numercus streams draining coal-mine areas has been altered dractically. The pH of water draining from mined areas commonly ranges from 2.1 to 5.0, generally has high sulfate and dissolved solids concentrations, is hard to very hard, and may contain objectionable amounts of iron. The detrimental quality of water in some streams may persist for decades after mining has ceased.

602979 PB-271 007/7
The Feasibility of Utilizing Solid Wastes for Building Materials. Executive Summary
Jackson, Gilbert ; Ware, Sylvia
Ebon Research Systems, Silver Spring, Md.
Sponsor: Municipal Environmental Research Lab., Cincinnati, Ohio.
Report No.: EPA/600/8-77/006
Jun 77 98p
NTIS Prices: PC A05/MF A01 Journal Announcement: GRAI7723
Contract No.: EPA-68-03-2460-1; EPA-68-03-2056

This report focuses on two phases of a suggested four phase study to evaluate the technological and commercial possibilities of waste - derived composites. The first phase involved a joint and comprehensive literature search to identify wastes with potential as building materials. Limited laboratory studies were conducted on composite materials produced from the more promising wastes investigated. A composite material was defined as a product containing a filler, a reinforcement and a matrix. Various characteristics were considered desirable for the filler, the reinforcement and the matrix. The wastes identified through the literature search were evaluated against these desirable properties. A listing of the evaluative criteria and the rating system used is presented. Filler materials reviewed included fly ash, crushed glass, phosphate slimes, silicate waste, shredded refuse, waste plastic, wood bark, rice hulls, taconite, red mud, coal waste foundry ash and sawdust. Reinforcement materials reviewed included carbonized lignin, bagasse, wheat straw, bark, kenaf, bamboo, wood chips, cotton waste and glass roving. Sewage sludge, sawdust, rice hulls, plastic scrap and waste glass also received attention as reinforcements.

602894 PB-270 911/1
Limestone and Lime Neutralization of Ferrous Iron Acid Mine Drainage
(Final rept. Jan 74-Jan 76)
Wilmoth, Roger C.
Environmental Protection Agency, Rivesville, W. Va. Resource Extraction and Handling Div.
Report No.: EPA/600/2-77-101
May 77 106p
NTIS Prices: PC A06/MF A01 Journal Announcement: GRAI7723

The U.S. Environmental Protection Agency conducted a 2-yr study on hydrated lime and rock-dust limestone neutralization of acid mine drainage containing ferrous iron at the EPA Crown Mine Drainage Control Field Site near Rivesville, West Virginia. The study investigated optimization of the limestone process and its feasibility in comparison with hydrated lime treatment. Operating parameters, design factors, and reagent costs for both processes were determined. Effluent quality was considered of prime importance in these investigations. Coagulants were considered essential to successful thickener operation for both lime and limestone treatment. Effluent iron, suspended solids, and turbidity values could be maintained below 3 mg/l, 10 mg/l, and 10 JTU, respectively, using coagulant addition. Although the limestone process was demonstrated to be technically effective in ferrous iron treatment situations, the process was judged to be less efficient overall in comparison with lime neutralization.

602776 PB-270 696/8
Longwall Ignition Suppression
(Final rept.)
Rothchild, Ronald D. ; Guzdar, Adi R.
Foster-Miller Associates, Inc., Waltham, Mass.
Corp. Source Codes: 142400
Sponsor: Bureau of Mines, Washington, D.C.
Report No.: BM-7511; BuMines-OFR-121-77
Sep 76 146p
NTIS Prices: PC A07/MF A01 Journal Announcement: GRAI7723
Contract No.: J0357089

This report describes the results of a study of longwall ignition hazards and specific suppression systems to minimize each of the major hazards. The major ignition hazards were identified by conducting a literature search and conversing with knowledgeable individuals in the United States mining industry. Three classes of potential ignition suppression systems are discussed: triggered suppression systems for face ignition, passive suppression systems, and control of ignition hazard in the gob. The triggered suppression systems included protection for the shearer, head and tail gates, welding equipment, and the shearer power cable. Passive systems include improved ventilation and water sprays, and charges in the shearer head. Gob protection can be improved by isolating the gob from working areas and by introducting inerting agents into the gob.

594320 PB-269 247/3
Research Needs for Mining and Industrial Solid Waste Disposal
Colorado State Univ., Fort Collins.
Corp. Source Codes: 088300
Sponsor: National Science Foundation, Washington, D.C. Div. of Engineering.
Jul 76 40p
Document Type: Conference proceeding
NTIS Prices: PC A03/MF A01 Journal Announcement: GRAI7720
Contract No.: NSF-ENG76-09380

Representatives of the geotechnical and environmental engineering professions, industry, and governmental agencies participated in a two-day Workshop to identify research needs in the area of mining and industrial solid waste disposal. This report, which was prepared by the participants during the Workshop, identifies 19 areas of needed research. The most critical need is for establishment of a reliable source of data concerning the magnitude of the waste disposal problem. Other areas of needed research are properties of wastes, seepage, surface stabilization, tailing dam design, site selection, design floods for retention structures, field instrumentation, abandonment, materials handling, material placement, climatic conditions, spontaneous combustion, and new methods of disposal.

589524 PB-267 715/1
Utilization of Mining and Milling Wastes
(Open file rept. (Final))
Bortz, S. A.
IIT Research Inst., Chicago, Ill. Mechanics of Materials Research Div.
Sponsor: Bureau of Mines, Washington, D.C.
Report No.: BuMines-OFR-101-77
Oct 76 21p
Pub. in Proceedings of the Mineral Waste Utilization Symposium (5th), Held on 13-14 April 1976.
Document Type: Conference proceeding; Journal article
NTIS Prices: PC A02/MF A01 Journal Announcement: GRAI7718
Contract No.: J0155151

This report presents a review of studies and investigations concerning materials, energy and products recovered from solid wastes. The bulk of the information presented is a summary of the 'Fifth Mineral Waste Utilization Symposium' which was organized and presented as the principal objective of this program. A total of 52 papers were presented. Contents: Metal recovery; Energy recovery from solid wastes; Waste utilization in construction; Conclusion.

589523 PB-267 714/4
Disposal of Mineral Wastes and Recovery of Water from Oxidized Taconite Slime Tailings
(Open file rept. (Final))
Yang, David C.
Michigan Technological Univ., Houghton. Inst. of Mineral Research.
Sponsor: Bureau of Mines, Washington, D.C.
Report No.: BuMines-OFR-102-77
Feb 77 140p
NTIS Prices: PC A07/MF A01 Journal Announcement: GRAI7718
Contract No.: J0255020

The report describes research to evaluate the flocculation, settling, and disposal of slimes and tailings from the beneficiation of oxidized taconite and to determine the effects of recycled water on the beneficiation process. The flocculation-desliming process was affected primarily by pH. The flotation process was affected by pH, amine concentration, and water hardness. There were no deleterious effects from recycling water.

585308 PB-266 766/3
Research and Development Priorities Summary Report for March 1, 1974 to March 31, 1977. Volume I. Executive Summary
(Final rept.)
Scott, James J.
Missouri Univ.-Rolla. Dept. of Mining, Petroleum, and Geological Engineering.
Sponsor: Bureau of Mines, Washington, D.C.
Report No.: BuMines-OFR-80(1)-77
15 Mar 77 148p
See also Volume 2, PB-266 767.
Document Type: Conference proceeding
NTIS Prices: PC A07/MF A01 Journal Announcement: GRAI7716
Contract No.: H0242034

The workshops covered under this report include lead mining in Missouri, limestone mining, coal mining both surface and underground in the midwest and in the Rocky Mountain area, iron mining in Minnesota, two top management meetings on institutional problems and, finally, a special two-day meeting on roof control.

586255 PB-266 724/4
Physical Properties of Western Coal Waste Materials
(Rept. of investigations)
Backer, R. R. ; Busch, R. A. ; Atkins, L. A.
Bureau of Mines, Spokane. Wash. Spokane Mining Research Center.
Corp. Source Codes: 390057
Report No.: BUMINES-RI-8216
1977 36p
See also report dated Sep 75, PB-245 841 and PB-240 022.
NTIS Prices: PC A03/MF A01 Journal Announcement: GRAI7716

This Bureau of Mines publication reports the typical physical and chemical properties of coal waste materials from the western part of the United States. These results are compared, in so far as possible, with the properties of waste materials from eastern coal operations. The authors found a disparity of mines and preparation plants among western U.S. coal operations, as well as dissimilarities with typical operations in the East. The relatively cleaner product from the predominance of surface mining and occurrence of thicker seams in the West reduces the amount of coal preparation required and the size of the waste piles. Because of the abundance of land available for waste disposal, many of the piles are low and extended over large areas. New concepts relating statistical shear strength data to liquifaction potential are presented. This report, along with the previously published information (BuMines RI's 7964 and 8062), should provide interested parties with information to plan and evaluate coal waste pile construction.

582479 PB-266 678/2
An Assessment of Technology for Possible Utilization of Bayer Process Muds
(Final rept.)
Parekh, B. K. ; Goldberger, W. M.
Battelle Columbus Labs., Ohio.
Corp. Source Codes: 407080
Sponsor: Industrial Environmental Research Lab.-Cincinnati, Ohio. Industrial Pollution Control Div.
Report No.: EPA/600/2-76/301
Dec 76 155p
NTIS Prices: PC A08/MF A01 Journal Announcement: GRAI7715
Contract No.: EPA-R-803760

The program comprised review of technical literature published from 1940 on subjects related to technology of processing bauxite, the dewatering and impoundment of the mud residues and their possible utilization. Mud samples were received from the domestic alumina plants for characterization experiments and dewatering studies at Battelle and at the laboratories of the Dow Chemical Company in Midland, Michigan. It was concluded from the study that there is no possibility for utilization of the muds that could significantly affect the need for impoundment within the near term. However, improved mud dewatering and methods of impoundment appear possible to develop and a program of joint industry-government demonstration and pilot projects is recommended. Investigations of the possible beneficiation of the muds into a raw material supplement in iron making and the possible use of mud as an absorbent in pollution abatement processes are also recommended.

582261 PB-266 413/4
Assessment of Environmental Aspects of Uranium Mining and Milling
(Final rept. 12 Feb-7 Jul 76)
Reed, A. K. ; Meeks, H. C. ; Pomeroy, S. E. ; Hale, V. Q.
Battelle Columbus Labs., Ohio.
Corp. Source Codes: 407080
Sponsor: Industrial Environmental Research Lab.-Cincinnati, Ohio. Resource Extraction and Handling Div.
Report No.: EPA/600/7-76/036
Dec 76 59p
NTIS Prices: PC A04/MF A01 Journal Announcement: GRAI7715
Contract No.: EPA-68-02-1323

This research program was initiated with the basic objective of making a preliminary assessment of the potential environmental impacts associated with the mining and milling of domestic uranium ores. All forms of pollution except radiation were considered. The program included a review of the characteristics and locations of domestic uranium ore reserves and a review of the conventional methods for mining and milling these ores. Potential environmental impacts associated with the entire cycle from exploration and mining to recovery and production of yellowcake are identified and discussed. Land reclamation aspects are also discussed. The methods currently used for production of yellowcake were divided into four categories - open pit mining-acid leach process, underground mining-acid leach process, underground mining-alkaline leach process, and in-situ mining. These are discussed from the standpoint of typical active mills which were visited during the program. Flowsheets showing specific environmental impacts for each category are provided.

582075 PB-266 172/8
Availability of Mining Wastes and Their Potential for Use as Highway Material. Volume III. Annotated Bibliography
(Final rept. Jun 75-Jun 76)
Collins, R. J.
Valley Forge Labs., Inc., Devon, Pa.
Sponsor: Federal Highway Administration, Washington, D.C.
Report No.: FHWA/RD-76/108
May 76 50p
See also Volume 2, PB-266 171.
Also available in set of 3 reports PC E09, PB-266 169-SET.
Document Type: Bibliography
NTIS Prices: PC A03/MF A01 Journal Announcement: GRAI7715
Contract No.: DOT-FH-11-8784

This annotated bibliography covers references on the production, characteristics, and uses of mining and metallurgical wastes, with particular emphasis placed on those references concerned with the engineering properties and highway-related uses of specific waste materials.

Highway Material. Volume II. Location of Mining and Metallurgical Wastes and Mining Industry Trends
(Final rept. Jun 75-Jun 76)
Collins, R. J.
Valley Forge Labs., Inc., Devon, Pa.
Sponsor: Federal Highway Administration, Washington, D.C.
Report No.: FHWA/RD-76-107
May 76 141p
See also Volume 1, PB-266 170.
Also available in set of 3 reports PC E09, PB-266 169-SET.
NTIS Prices: PC A07/MF A01 Journal Announcement: GRAI7715
Contract No.: DOT-FH-11-8784

This study was performed to determine the availability of mining and metallurgical wastes and to assess their potential for use in highway construction. A large number of information sources were used to develop an inventory and classification system for these wastes. Information presented in Volume II was obtained mainly from knowledgeable personnel in the mining industry and government agencies, supplemented by key reports and industry periodicals. Maps and tabulations of mineral wastes from 35 principal mining states are presented in this volume.

582073 PB-266 170/0
Availability of Mining Wastes and Their Potential for Use as Highway Material. Volume I. Classification and Technical and Environmental Analysis
(Final rept. Jun 75-Jun 76)
Collins, R. J. ; Miller, R. H.
Valley Forge Labs., Inc., Devon, Pa.
Sponsor: Federal Highway Administration, Washington, D.C.
Report No.: FHWA/RD-76-106
May 76 308p
Also available in set of 3 reports PC E09, PB-266 169-SET.
NTIS Prices: PC A14/MF A01 Journal Announcement: GRAI7715
Contract No.: DOT-FH-11-8784

Over 1.6 billion tons of mining and metallurgical wastes are produced each year. Although a small percentage of all this material is actually being used, a number of mining and metallurgical wastes have been successfully utilized as highway construction material. A number of other mineral wastes are potentially useful with some degree of processing. Materials most highly recommended for use in highway construction are gold gravels, steel slag, lead-zinc chat, phosphate slag, taconite tailings, copper slag, and waste rock from the mining of copper, fluorspar, gold, and iron ore.

572030 PB-264 936/6
Water Pollution Caused by Inactive Ore and Mineral Mines - A National Assessment
(Final rept.)
Martin, Harry W. ; Mills, Jr, William R.
Toups Corp., Santa Ana, Calif.
Sponsor: Industrial Environmental Research Lab.-Cincinnati, Ohio. Resource Extraction and Handling Div.
Report No.: EPA/600/2-76/298
Dec 76 198p
NTIS Prices: PC A09/MF A01 Journal Announcement: GRAI7712
Contract No.: EPA-68-03-2212

The report identifies the scope and magnitude of water pollution from inactive ore and mineral mines. Data collected from Federal, State, and local agencies indicates water pollution from acids, heavy metals, and sedimentation occurs at over 100 locations and affects over 1200 kilometres of streams and rivers. The metal mining industry was shown to be the principal source of this pollution. Descriptions of the mineral industry are presented, including a summary of economic geology, production methods, and historic mineral production methods, and historic mineral production. The mechanisms of formation, transportation, and removals of pollutants are detailed. Annual pollutant loading rates for acid and metals from inactive mines are given and a method provided to determine the extent of mine-related sedimentation in Western watersheds. State-by-state summaries of mine related pollution are presented. An assessment of current water pollution abatement procedures used for inactive mines is given and research and development programs for necessary improvements are recommended.

568631 PB-264 289/0
Acid Mine Drainage Treatment with the Rotating Biological Contactor
Olem, Harvey ; Unz, Richard F.
Pennsylvania State Univ., University Park. Inst. for Research on Land and Water Resources.
Sponsor: Office of Water Research and Technology, Washington, D.C.
Report No.: RESEARCH PUB-93; W77-05210; OWRT-A-034-PA(2)
Sep 76 81p
NTIS Prices: PC A05/MF A01 Journal Announcement: GRAI7711
Contract No.: DI-14-31-0001-5038; OWRT-A-034-PA

Pilot scale testing of the rotating biological contactor for the oxidation of ferrous iron in acid coal mine drainage has shown the process to be dependable, efficient, and economically comparable to purely chemical methods of iron oxidation. The 0.5 meter device consisted of four sets of plastic discs affixed to a centralized shaft. As the discs rotated half immersed in flowing mine water, an average iron-oxidizing bacterial population of 70,000 cells per sq cm colonized the disc surfaces. Over 90% oxidation of influent ferrous iron was accomplished in two weeks following start up without prior bacterial preseeding or nutrient supplementation. Concentration dependent first order kinetics were established during continuous operation from May 1974 through May 1975 at several hydraulic loadings and disc rotation rates. Performance was not impaired when operated at mine water temperatures as low as 8C. Two procedures were outlined to assist sizing full scale systems for mine water biochemical ferrous iron oxidation.

561492 PB-262 737/0
Electrokinetic Consolidation of Slimes in an Underground Mine
(Rept. of investigations)
Sprute, R. H. ; Kelsh, D. J.
Bureau of Mines, Spokane, Wash. Spokane Mining Research Center.
Corp. Source Codes: 390057
Report No.: BUMINES-RI-8190
Dec 76 38p
NTIS Prices: PC A03/MF A01 Journal Announcement: GRAI7709

These tests demonstrated that electrokinetic treatment of underground slime deposits can sufficiently harden them to permit their removal or use as backfill. Therefore, slimes can be effectively utilized underground, either as part of unclassified tailings subjected to electrokinetic treatment in primary stopes, or as taken from slime sumps. It is hoped that ultimately all slimes can be used as backfill, thereby eliminating the need for their aboveground disposal. This could best be accomplished by dewatering unclassified tailings to a much greater extent--approximately 70 wt-pct solids--before placing them in primary stopes. Such thickened slurries respond exceptionally well to electrokinetic treatment; they are easily transported hydraulically, and segregate to only a negligible extent on placement. Electrokinetic hardening of these deposits could create a dense, high-modulus backfill that would provide greater support for mine walls, men, and equipment than is attained by the coarse classified sand now in use.

558144 PB-262 819/6
Effects of Uranium Mining and Milling on Ground Water in the Grants Mineral Belt, New Mexico
Kaufmann, Robert F. ; Eadie, Gregory G. ; Russell, Charles R.
Office of Radiation Programs, Las Vegas, Neb.
1 Feb 77 14p
Pub. in Ground Water, v14 n6 Sep-Oct 76.
Document Type: Journal article
NTIS Prices: PC A02/MF A01 Journal Announcement: GRAI7708

Ground-water contamination from uranium mining and milling results from the infiltration of mine, mill, and ion-exchange plant effluents containing elevated concentrations of radium, selenium, and nitrate. Available data indicate that radium concentrations in the discharge waters of a producing mine tend to increase substantially as the ore body is developed. Whereas natural background radium concentrations are generally about several picocuries/liter (pCi/l), 100 to 150 pCi/l appear in the effluents of operating mines. The discharge of such highly contaminated mine effluents to streams and seepage from tailings ponds, creates a long-lived source of ground-water contamination. Seepage of mill tailings at two active mills ranges from 126,000 to 491,000 cu m/yr and, to date, has contributed an estimated 2400 Curies of uranium, radium, and thorium to the ground-water reservoir. Radium, selenium, nitrate and, to a lesser extent, uranium, are of most value as indicators of ground-water contamination.

557974 PB-262 545/7
Proceedings - Kentucky Coal Refuse Disposal and Utilization Seminar (2nd), Held at Pine Mountain State Resort Park, Pineville, Kentucky on May 20-21, 1976
Rose, Jerry G.
Kentucky Univ., Lexington. Inst. for Mining and Minerals Research.
Report No.: IMMR21-PD15-76
Sep 76 115p
See also PB-249 304.
Document Type: Conference proceeding
NTIS Prices: PC A06/MF A01 Journal Announcement: GRAI7708

Contents: Overview of ERDA's public information program and technology transfer to industry with particular regard to fossil fuel development; How ARC helps local areas with abandoned mine problems; Appalachian Kentucky--An enterprise development approach; Coal refuse in highway embankments and aggregates; Kentucky coal preparation plant refuse characterization and uses; Modifying slopes to improve embankment stability; Soil mechanics tests on coal mine spoils; Selected soil mechanics properties of Kentucky coal preparation plant refuse; Coal ash and coal refuse--new potential resources; Choosing closed circuits for coal preparation plants; Chemical stabilization of fine coal refuse with Calcilox additive stabilization techniques; Primary and secondary coarse coal cleaning; Fine coal drying; Use of flocculants and coagulants in coal refuse dewatering; Cyclone cleaning of fine coal refuse; List of attendees and acknowledgments; Appendix--Current publications of the Institute for Mining and Minerals Research.

553895 NTIS/PS-77/0040/4
Coal Mine Waste (A Bibliography with Abstracts)
(Rept. for 1964-Nov 76)
Smith, Mona F.
National Technical Information Service, Springfield, Va.
Corp. Source Codes: 391812
Feb 77 104p
Supersedes NTIS/PS-75/112, and NTIS/PS-76/0053.
Document Type: Bibliography
NTIS Prices: PC N01/MF N01 Journal Announcement: GRAI7707

Research topics cover coal mining refuse, refuse dumps and spoil. Studies on disposal, utilization, environmental impacts and testing of these wastes are included, as are reports on land reclamation and spoil bank safety. (This updated bibliography contains 99 abstracts, 23 of which are new entries to the previous edition.)

543898 PB-259 930/6
Treatment of Acid Mine Drainage by the Alumina-Lime-Soda Process
(Final rept. Aug 74-Dec 75)
Nebgen, J. W. ; Weatherman, D. F. ; Valentine, M. ; Shea, E. P.
Midwest Research Inst., Kansas City, Mo.
Corp. Source Codes: 230350
Sponsor: Industrial Environmental Research Lab., Cincinnati, Ohio. Office of Research and Development.
Report No.: EPA/600/2-76/206
Sep 76 105p
NTIS Prices: PC A06/MF A01 Journal Announcement: GRAI7704
Contract No.: EPA-S-802816

The alumina-lime-soda process is a chemical desalination process for waters in which the principal sources of salinity are sulfate salts and has been field tested at the Commonwealth of Pennsylvania's Acid Mine Drainage Research Facility, Hollywood, Pennsylvania, as a method to recover potable water from acid mine drainage. The alumina-lime-soda process involves two treatment stages. Raw water is reacted with sodium aluminate and lime in the first stage to precipitate dissolved sulfate as calcium sulfoaluminate. In the second stage, the alkaline water (pH = 12.0) recovered from the first stage is carbonated to precipitate excess hardness. Following carbonation, product water meets USPHS specifications for drinking water. Alumina-lime-soda process economics are influenced most by the cost of sodium aluminate.

532720 PB-258 104/9
Fluidized Coke-Bed Chlorination of Ilmenites
(Rept. of investigations 1976)
Harris, Henry M. ; Henderson, Arthur W. ; Campbell, Thomas T.
Bureau of Mines, Albany, Oreg. Albany Metallurgy Research Center.
Corp. Source Codes: 401977
Report No.: BUMINES-RI-8165
Aug 76 25p
NTIS Prices: PC A02/MF A01 Journal Announcement: GRAI7626

The Bureau of Mines investigated chlorination of domestic ilmenites in a fluidized coke bed at temperatures of 950 to 1,150C. Objectives were to develop an effective process for producing TiCl4 suitable for TiO2 pigment and to reduce pollution by collecting and treating waste byproduct chlorides. The reactor for these tests was a 10.2-cm-diam quartz tube heated externally by electrical resistance heaters. Ilmenite concentrate powders were introduced at the bottom of the fluid-bed reactor using the chlorine gas stream as a carrier. Test results showed that greater than 90 pct of the ilmenite reacted at optimum conditions and recovery of TiCl4 ranged from 95 pct to 99 pct of stoichiometric. A temperature-controlled cyclone was used to remove high-boiling-point chlorides, unreacted ilmenite and coke dust. Impure TiCl4 and FeCl3 were separated by fractional condensation. Liquid TiCl4 was purified to meet specifications for pigment-grade chloride. Integrated tests were conducted in which chlorine, produced by dechlorination of FeCl3 with oxygen, was recycled and used directly in a fluidized-bed chlorinator.

528698 PB-257 739/3
Extensive Overburden Potentials for Soil and Water Quality
(Final rept. 1 Nov 73-1 Apr 75)
Smith, Richard M. ; Sobek, Andrew A. ; Arkle, Jr., Thomas ; Sencindiver, John C. ; Freeman, John R.
West Virginia Univ., Morgantown. Div. of Plant Sciences.
Sponsor: West Virginia Geological and Economic Survey, Morgantown.; Industrial Environmental Research Lab., Cincinnati, Ohio.
Report No.: EPA/600/2-76/184
Aug 76 329p
Prepared in cooperation with West Virginia Geological and Economic Survey, Morgantown.
NTIS Prices: PC A15/MF A01 Journal Announcement: GRAI7625
Contract No.: EPA-R-802603-01

Chemical, physical and mineralogical measurements and interpretations developed during previous studies in West Virginia have been improved and applied to coal overburden columns in 12 widely spaced Neighborhoods and 2 Adjunct locations in 10 states, from Pennsylvania on the Northeast to Alabama on the southeast and Oklahoma on the west. Field studies in each Neighborhood and Adjunct location involved logging and sampling soil and rock horizons from surface to coal, testing and improving field clues, determining properties of mine soils and water resulting from mining operations, and checking reclamation. Consistent overburden property relationships within basins and over particular named coals provide opportunities for generalizations and extra-polation between sampled sites. It appears feasible to use detailed information from overburden sampling and analysis as an aid to pre-mining planning of surface mining operations including reclamation and projected land use.

528472 NTIS/PS-76/0816/9
Acid Mine Drainage (A Bibliography with Abstracts)
(Rept. for 1964-Sep 76)
Brown, Robena J.
National Technical Information Service, Springfield, Va.
Corp. Source Codes: 391812
Oct 76 189p
Supersedes NTIS/PS-75/714, and NTIS/PS-75/046.
Document Type: Bibliography
NTIS Prices: PC N01/MF N01 Journal Announcement: GRAI7625

The bibliography on acid mine drainage cites studies primarily concerning control and treatment methods. Also included are reports on hydrogeology, ecology, formation, and sources. (This updated bibliography contains 184 abstracts, 34 of which are new entries to the previous edition.)

521611 PB-256 394/8
Metals Mining and Milling Process Profiles with Environmental Aspects
(Final rept. Aug 75-May 76)
Markervis, R. J. ; Hallowell, J. B.
Battelle Columbus Labs., Ohio.
Corp. Source Codes: 407080
Sponsor: Industrial Environmental Research Lab., Research Triangle Park, N.C.
Report No.: EPA/600/2-76/167
Jun 76 318p
NTIS Prices: PC A14/MF A01 Journal Announcement: GRAI7622
Contract No.: EPA-ROAP-21AFH-025; EPA-ROAP-21AFH-025

The report describes the environmental aspects of metals mining and milling (concentration) operations in the U.S. The metals include Al, Sb, Be, Cu, Au, Fe, Pb, Zn, Hg, Mo, Ni, Pt, the rare earth metals, Ag, Ti, W, U, and V. The types of environmental impacts associated with operations from mining through production of concentrate are described in general terms. The number and locations of plants, the names of producing companies, production levels, and other characteristics of the industry is presented. Each unit process is described in terms of function, input materials, operating conditions, utilities and energy use, and waste streams. The descriptions of unit processes identify waste streams in terms of emissions to the air, water effluents, and solid wastes disposed to the land. The approximately 185 unit operations described include mining, dredging, crushing, flotation, leaching, sintering, and nodulizing. The most common waste streams are dusts from mining and crushing operations, liquid streams from mine drainage, flotation operations, tailings ponds, and leaching operations.

521479 PB-256 120/7
Waste Materials as Potential Replacements for Highway Aggregates
(Final rept.)
Miller, Richard H. ; Collins, Robert J.
Valley Forge Labs., Devon, Pa.
Sponsor: American Association of State Highway and Transportation Officials, Washington, D.C.; Transportation Research Board, Washington, D.C.
Report No.: ISBN-0-309-0233-1; TRB/NCHRP/REP-166
Jun 76 108p
Prepared in cooperation with American Association of State Highway and Transportation Officials, Washington, D.C.
NTIS Prices: PC E03/MF A01 Journal Announcement: GRAI7622
Contract No.: NCHRP-4-10A

This report documents and presents the results of a comprehensive survey of the technical and economic potential for making use of waste materials as alternative aggregates in highway construction and maintenance. The survey included an assessment of the availability of conventional aggregates to determine where competitive opportunities for the introduction of new materials are most likely to exist. Information was obtained from over 300 relevant documents and supplemented by numerous contacts with agencies and individuals in both the highway and waste management fields. Of an initial group of 34 waste products that were examined for use in highway aggregate production, 30 were judged to have some promise. Technical, economic, and environmental evaluations that were made through a system developed on the project showed iron blast furnace slag; fly ash, bottom ash and boiler slag from electric power generating stations; reclaimed paving material; and anthracite coal mine refuse to offer the best opportunities for further development.

516758 PB-253 609/2
Evaluation of Solid Waste Materials for Highway Uses
(Final rept.)
Wolters, R. O. ; Cassellius, R. H.
Minnesota Dept. of Highways, St. Paul. Office of Research Coordination.
Report No.: INVESTIGATION-638; MN-HW-5-180-75-4
1975 40p
NTIS Prices: PC A03/MF A01 Journal Announcement: GRAI7621

This report is meant as a 'state of the art' on utilization of solid waste material for road construction and maintenance. There are many waste materials, but in Minnesota three products are of prime interest because they are available in such large quantities. These are: taconite tailings, fly ash, boiler slag. Much study has been done on some of those large volume materials. Some of the successful uses found for these products are embankment fill, subbase, base stabilizer for soil or aggregate, paving aggregate, and bituminous mix components.

513116 PB-254 549/9

Concentration of Heavy Metals in Sediments of a Hydroelectric Impoundment

(Completion rept.)

Bailey, Ann K. ; Weisel, George F.

Montana State Univ., Bozeman. Water Resources Research Center.

Sponsor: Office of Water Research and Technology, Washington, D.C.; Montana Univ., Missoula. Dept. of Zoology.

Report No.: MUJWRRC-75; W76-09755; OWRT-A-086-MONT(1)

Mar 76 70p

Prepared in cooperation with Montana Univ., Missoula. Dept. of Zoology.

NTIS Prices: PC A04/MF A01 Journal Announcement: GRAI7619

Contract No.: OWRT-A-086-MONT

Milltown Dam, located near Bonner, Montana, has acted as a settling basin for 69 years for wastes in the Clark Fork River originating from the Butte mines and Anaconda Copper Mining Company smelter 95 miles upstream. This study undertook the determination of the amounts of heavy metals accumulated in the sediments of Milltown reservoir. Sediments in the Blackfoot River portion of the reservoir were used for comparison with the Clark Fork River sediments. Sediment cores from the Clark Fork River had high levels of Cu, Zn, and Mn compared to sediments reported in other studies and to a core taken from the Blackfoot River. Peaks of high Cu, Zn, Mn, and Fe concentrations were found at the same depth within most of the Clark Fork cores. Cu concentration ranged in these cores from 50-7,900 microgram/gm; Zn ranged from 300-7,900 microgram/gm; Mn ranged from 350-2,900 microgram/gm; Fe ranged from 10,500-43,300 microgram/gm. The peaks of metal concentration were concluded to be caused by changes in operations, smelter shutdowns, and spills from settling ponds near Anaconda. Macroinvertebrates in sediment samples were predominately oligochaetes and one species of dipteran (Chironomus (Chironomus) sp.).

513043 PB-254 453/4

A Chemical and Biological Evaluation of Three Mine Drainage Treatment Plants

McPhilliamy, Scott C. ; Green, James

Environmental Protection Agency, Wheeling, W. Va. Surveillance and Analysis Div.

Report No.: WORK DOCUMENT-47

Jun 73 81p

NTIS Prices: PC A05/MF A01 Journal Announcement: GRAI7619

Chemical and biological sampling was conducted at three mine drainage treatment plants operating in Washington County, Pennsylvania. In addition to the parameters generally associated with mine drainage, ten additional parameters were included for analysis during three of the four sampling rounds. These were all metals and included manganese, aluminum, calcium, magnesium, cadmium, chromium, copper, lead, nickel and zinc. These metals were included in a general attempt to observe the efficiency of a conventional mine drainage treatment plant for the removal or reduction of metals not commonly associated with mine drainage but often present in measurable quantities.

510931 PB-253 766/0

Trough Creek Limestone Barrier Installation and Evaluation

(Final rept. Jun 70-Feb 75)

Yocum, S. Curtis

Africa Engineering Associates, Inc., Huntingdon, Pa.

Sponsor: Industrial Environmental Research Lab., Cincinnati, Ohio.

Report No.: EPA/600/2-76/114

May 76 101p

NTIS Prices: PC A06/MF A01 Journal Announcement: GRAI7618

Contract No.: EPA-14010-FWW

Six prototype crushed limestone barrier installations were constructed in Trough Creek in South Central Pennsylvania to demonstrate the neutralizing ability of this type structure in low-iron acidic streams. Limestone barrier performance was excellent during periods of low streamflow, in terms of reducing acidity and raising the pH of the water, but their effectiveness was marginal at design or average streamflow, and they were ineffective when high runoffs were experienced. Limestone barrier performance deteriorates after the structures are initially constructed and placed in operation, because progressive accumulations of sediment clog interstices between the stones, which lessens the hydraulic conductivity of the barriers, and surfaces of the stones become coated with silt, which causes a reduction in reactivity of the reagent (limestone) with flowing acidic water. The design of limestone barriers should take these factors into account, and the units should be sized sufficiently large to overcome this deficiency.

510861 PB-253 609/2
Evaluation of Solid Waste Materials for Highway Uses
(Final rept.)
Wolters, R. O. ; Casselius, R. H.
Minnesota Dept. of Highways, St. Paul. Office of Research Coordination.
Report No.: INVESTIGATION-638; MN-HW-5-180-75-4
1975 40p
NTIS Prices: PC A03/MF A01 Journal Announcement: GRAI7618

This report is meant as a 'state of the art' on utilization of solid waste material for road construction and maintenance. There are many waste materials, but in Minnesota three products are of prime interest because they are available in such large quantities. These are: taconite tailings, fly ash, boiler slag. Much study has been done on some of these large volume materials. Some of the successful uses found for these products are embankment fill, subbase, base stabilizer for soil or aggregate, paving aggregate, and bituminous mix components.

510787 PB-253 346/1
Taconite Tailings Disposal, Reserve Mining Company, Silver Bay, Minnesota
(Concept evaluation rept.)
Weston, Roy F. ; Woldman, Michael L.
Weston (Roy F.), Inc., West Chester, Pa.
Sponsor: Environmental Protection Agency, Washington, D.C.
27 Oct 71 179p
Sponsored in part by Environmental Protection Agency, Washington, D.C.
NTIS Prices: PC A09/MF A01 Journal Announcement: GRAI7618

The overall objective of this assignment is to develop minimum cost solutions consistent with the conference guidelines for protecting the environment in general and for conformance to the federally-approved 'Specific Standards of Quality and Purity for Lake Superior' (contained in WPC 15) in particular. The limits or ranges of the various contaminant substances specified in 'Specific Standards of Quality and Purity for Lake Superior' are shown. It should be noted that the assignment essentially was a presentation of an impartial evaluation rather than development of specific conclusions and recommendations. The sections cover the following: the major issues developed by previous studies of tailings discharges to Lake Superior, technical review of previous proposals for treatment and disposal of taconite tailings, discussion of ROY F. WESTON process investigation and tailings reuse, concept design of various alternatives for tailings processing and disposal, and the economic and financial impact on Reserve Mining and on the State of Minnesota of implementation of various proposals for taconite tailings disposal.

501476 PB-252 176/3
Vegetative Stabilization of Mineral Waste Heaps
(Final rept.)
Donovan, R. P. ; Felder, R. M. ; Rogers, H. H.
Research Triangle Inst., Research Triangle Park, N.C.
Corp. Source Codes: 304400
Sponsor: Industrial Environmental Research Lab., Research Triangle Park, N.C.
Report No.: EPA/600/2-76/087
Apr 76 318p
NTIS Prices: PC A14/MF A01 Journal Announcement: GRAI7613
Contract No.: EPA-68-02-1325; EPA-ROAP-21AVA-008

The report reviews the establishment of vegetative cover as a candidate method for reclaiming mineral ore waste heaps. It begins by describing the location and properties of spoils and tailings from mining and ore beneficiation, and briefly reviews present methods for controlling dust emissions from them. Most of the report develops fundamentals for establishing vegetative cover, and gives a detailed review of case histories of both successful and unsuccessful revegetation. The report also contains a catalog of individual plant species. This mass of information can be used to provide general guidelines for establishing vegetative cover.

499589 CONF-751213-3
Preliminary Report on Fluid-Bed Combustion of Anthracite Wastes
Wilson, J. S. ; Gillmore, D. W.
Energy Research and Development Administration, Morgantown, W.Va. Morgantown Energy Research Center.
Corp. Source Codes: 9500847
1975 14p
Document Type: Conference proceeding
NTIS Prices: PC A02/MF A01 Journal Announcement: GRAI7612 ; NSA0104

Millions of tons of anthracite refuse and silt bank materials are potential low-carbon, high-ash fuels for fluid-bed combustion. In preliminary tests in an 18-in.-dia atmospheric pressure fluidized-bed combustor at the Morgantown Energy Research Center (ERDA), Powderly Bank silt (66 percent C, 24 percent ash) and Mid-Valley Bank refuse (25 percent C, 65 percent ash) were successfully burned in 36-in. and deeper beds at temperatures of 1600 sxp 0 F and above.

499148 PB-251 929/6
The Operation of the Humeca Uranium Mill, Rio Algom Corporation. Docket No. 40-8084
(Final environmental statement)
Nuclear Regulatory Commission, Washington, D.C. Div. of Fuel Cycle and Material Safety.
Report No.: NUREG-0046
Apr 76 679p
NTIS Prices: PC A99/MF A01 Journal Announcement: GRAI7612

A Final Environmental Statement for the Humeca Uranium Mill operated by Rio Algom Corporation (Docket No. 40-8084) located in San Juan County, Utah, has been prepared by the Division of Fuel Cycle and Material Safety of the Nuclear Regulatory Commission. This statement provides a summary of environmental impact and adverse effects of the facility. Also included are the comments of Federal, State, and local governmental agencies, and certain non-governmental organizations, on the Draft Environmental Statement for the facility and staff responses to these comments. Portions of this document are not fully legible.

498877 PB-251 391/9
Impact of Coal Stripmining on Water Quality and Hydrology in East Tennessee
(Completion rept.)
Tschantz, Bruce A. ; Minear, Roger A.
Tennessee Univ., Knoxville. Water Resources Research Center.
Sponsor: Office of Water Research and Technology, Washington, D.C.; Tennessee Univ., Knoxville. Dept. of Civil Engineering.
Report No.: 47; W76-05833; OWRT-A-041-TENN(1)
30 Nov 75 52p
Prepared in cooperation with Tennessee Univ., Knoxville. Dept. of Civil Engineering.
NTIS Prices: PC A04/MF A01 Journal Announcement: GRAI7612
Contract No.: DI-14-31-0001-5043; OWRT-A-041-TENN

Six small watersheds (0.7 to 4.9 sq mi) within the New River Basin of the Northern Tennessee Cumberland Mountains have been monitored weekly and simultaneously for water quality between January and September, 1975. Three watersheds were undisturbed by mining activity and served to establish bench mark data. The other three watersheds represented varying stages of coal mining in one watershed to essentially complete stripping three years ago and current deep mining activity in another. Distinct differences are observed were the variables, pH, alkalinity, sulfate, calcium, magnesium, iron manganeses, total solids and suspended solids among the disturbed watersheds in contrast to the undisturbed watershed stream constituent concentrations were quite uniform from stream to stream and from sample to sample.

498458 PB-250 751/5
Radium Removal from Uranium Ores and Mill Tailings
(Rept. of investigations 1975)
Borrowman, S. R. ; Brooks, P. T.
Bureau of Mines, Salt Lake City, Utah. Salt Lake City Metallurgy Research Center.
Report No.: BUMINES-RI-8099
Jan 76 16p
Presented at the Annual AIME Meeting, Chicago, Ill., Feb. 26-Mar. 1, 1973.
Document Type: Conference proceeding
NTIS Prices: PC A02/MF A01 Journal Announcement: GRAI7611

Mill tailings from conventional uranium extraction processes contain nearly all of the radium originally in the ore. Such tailings require controlled storage in perpetuity to safeguard the surrounding environment from radioactive contamination. Alternatives to controlled storage of the tailings are either removal of the radium from the tailings for separate storage or use, or separate removal of the radium when processing the uranium ore. The latter alternative would best apply to future mills. To prevent scattering of radioactive particles by wind and water erosion, tailings piles have been treated either by covering with earth or by spraying with crust-forming chemicals. In laboratory tests, radium was leached from tailings using either hydrochloric acid or ethylene diamine tetra acetic acid. A hydrochloric acid leaching method was used for extracting both radium and uranium from the ore to yield tailings containing less radium than tailings produced by either conventional sulfuric acid or alkaline leaching processes.

496417 PB-250 675/6
Gamma Radiation Surveys at Inactive Uranium Mill Sites
(Final rept.)
Douglas, Richard L. ; Hans, Jr, Joseph M.
Office of Radiation Programs, Las Vegas, Nev.
Report No.: ORP/LV-75-5
Aug 75 97p
NTIS Prices: PC A05/MF A01 Journal Announcement: GRAI7611

This report presents the results of gamma radiation surveys conducted by the Office of Radiation Programs at twenty inactive uranium mill sites in the Western United States. The purpose of these surveys was to measure the extent to which radioactive material had been spread into the environment from the sites by the action of wind and/or water erosion, and by milling activities. The results indicate that hundreds of acres of land exclusive of the tailings piles have been contaminated to above-background levels. Some of the contaminated land is private, off-site property. Survey techniques were developed to locate the spread radioactive materials and to estimate the gamma exposure rates resulting from them. These measurements were complicated by the presence of direct gamma radiation from the tailings piles. Iso-exposure rate lines were located around each site and plotted on site maps to facilitate site decontamination decisions.

493864 PB-249 860/6
Tolerance and Synthetic Ability of Sewage Microorganisms in Acid Mine Water
Thompson, Frederick C. ; Wilson, Harold A.
West Virginia Univ., Morgantown. Water Research Inst.
Sponsor: Office of Water Research and Technology, Washington, D.C.
Report No.: BULL-5; W76-04725; OWRT-A-018-WVA(2)
1975 73p
NTIS Prices: PC E03/MF A01 Journal Announcement: GRAI7610
Contract No.: DI-14-31-0001-3049; OWRT-A-018-WVA

Rhodotorula mucilaginosa withstood exposure to low pH levels in buffered solutions better and was less susceptible to cytoplasmic loss than Escherichia coli. Studies indicated that populations that survived the initial shock metabolized endogenously for varying periods then resumed normal metabolic activity. When placed in low pH buffered solutions, phosphates, 3H-thymidine, and amino acids were almost immediately released, but little was released after the initial loss. A continuous loss of purine and pyrimidine-base compounds was indicated. R. mucilaginosa did not show appreciable loss of phosphate, but E. coli did with time. E. coli cells that survived the initial pH shock continued metabolic activity more rapidly at 37C than 22C. R. mucilaginosa respired well at 22C. Increasing iron concentrations influenced respiratory rates of the bacterium more than that of the yeast. Ferric iron appeared more inhibitory than ferrous. Both microbes released amino acids into the buffers. E. coli more efficiently recovered its lost amino acids at higher pH levels than the yeast. At low pH levels, both were generally unable to recover amino acids.

491781 PB-249 300/5
Proceedings of the Polish - U.S. Symposium 'Environmental Protection in Openpit Coal Mining' Held at Denver, Colorado on 27-29 May 1975
(Final rept.)
Craig, John ; Libicki, Jacek
Denver Research Inst., Colo.
Corp. Source Codes: 106600
Sponsor: Environmental Protection Agency, Washington, D.C. Office of International Activities.
Report No.: A-7501
17 Dec 75 165p
Document Type: Conference proceeding
NTIS Prices: PC A08/MF A01 Journal Announcement: GRAI7609
Contract No.: EPA-68-01-1769; DRI-5259

Proceedings of May 27-29, 1975 Polish-U.S. Symposium on 'Environmental Protection of Openpit Coal Mines,' contains 18 papers on openpit coal mining, techniques, refuse disposal, hydrology, water purification, run-off, sediment control, uses of fly ash, toxicity of water, waste stabilization, use of byproducts, dewatering techniques, and surface reclamation.

489638 PB-249 694/1

Elastic-Plastic Stability Analysis of Mine-Waste Embankments

(Rept. of investigations)

Corp, Ernest L. ; Schuster, Robert L. ; McDonald, Michael M.

Bureau of Mines, Spokane, Wash. Spokane Mining Research Center.

Corp. Source Codes: 390057

Report No.: BUMINES-RI-8069

Nov 75 107p

NTIS Prices: PC A06/MF A01 Journal Announcement: GRAI7608

Seepage forces computed by a finite-element flow program are combined with gravity forces in an elastic-plastic stress-analysis program to determine the stability of mine-waste slopes. Computer output provides a cross-sectional plot of the dam or embankment showing the safety factors for each element. The combined finite-element program called SEEP-SLOPE was used to analyze several trial embankments and the 1972 Buffalo Creek Dam failure. Safety factors computed by the finite-element method (FEM) were compared with those computed by Bishop limiting-equilibrium method. For individual slip circles, there was little correlation between the factors of safety computed by the two methods. Both predict failure, but FEM shows a different mode of failure plus development of potential failure zones not indicated by conventional methods. Besides having a better theoretical basis than the Bishop method, FEM requires no assumptions regarding the location or geometry of the failure zone. The program will show progressive development of a failure zone, and areas can be pinpointed where remedial measures should be taken. Non-homogeneous cross-sections can be analyzed, and zones of potential piping can be defined.

489354 PB-249 304/7

Proceedings of Kentucky Coal Refuse Disposal and Utilization Seminar (1st) Held at Cumberland, Kentucky on 22 May 1975

Kentucky Univ., Lexington. Inst. for Mining and Minerals Research.

Report No.: IMMR9-PD7-75

Dec 75 56p

Document Type: Conference proceeding

NTIS Prices: PC A04/MF A01 Journal Announcement: GRAI7608

This document contains the proceedings of the First Kentucky Coal Refuse Disposal and Utilization Seminar held at Southeast Community College in Cumberland, Kentucky, May 22, 1975. The Seminar was attended by 77 persons representing coal industry operators, mining and civil engineers, representatives of federal, state and local governmental agencies, local business leaders and college students. Topics discussed were: Recent European practice in coal refuse utilization; Utilization of Pennsylvania anthracite refuse; Utilization of coal mine waste for strata control; Water quality aspects of coal refuse utilization; Characteristics of a good industrial site; Improving mining technology and its implications for local land use planning; Possibilities from the area development districts and local initiative standpoints; Local government involvement in coal refuse utilization, technical memorandum; Local problems and research needs for optimum disposal and utilization of coal refuse; The coal operator's participation in community development.

486983 NTIS/PS-76/0053/9

Coal Mine Waste (A Bibliography with Abstracts)

(Rept. for 1964-Nov 75)

Smith, Mona F.

National Technical Information Service, Springfield, Va.

Corp. Source Codes: 391812

Feb 76 83p

Supersedes NTIS/PS-74/112.

Document Type: Bibliography

NTIS Prices: PC N01/MF N01 Journal Announcement: GRAI7607

Research topics cover all aspects of coal mining refuse, refuse dumps, disposal, and utilization. (This updated bibliography contains 78 abstracts, 27 of which are new entries to the previous edition.)

484147 PB-247 224/9

Electrokinetic Densification of Hydraulic Backfill. A Field Test

(Rept. of investigations)

Sprute, R. H. ; Kelsh, D. J.

Bureau of Mines, Spokane, Wash. Spokane Mining Research Center.

Corp. Source Codes: 390057

Report No.: BUMINES-RI-8075

1975 25p

NTIS Prices: PC A02/MF A01 Journal Announcement: GRAI7605

Hydraulic backfill consisting of siliceous mill tailings was successfully dewatered and consolidated by electrokinetics in a field test conducted at the Star mine, Burke, Idaho. Work was planned and performed by the Bureau of Mines, with the assistance of Hecla Mining Company personnel and management. A stope at the 2,000-foot level was filled in such a way that slimes as well as coarse sand were retained in the stope. Following settlement of solids and decant of surface water, direct current applied between buried electrodes created a firm, dense material in approximately three hours. This rapid densification of fine-grained material demonstrated the utility of this method and suggests other applications, particularly in the control of slime deposits that cause serious problems in many deep mines. These wastes can be converted to competent support material.

481461 PB-247 313/0

Cleaning Coal with Coal: Coal Humic Acids for Removal of Acid, Iron, Heavy Metals, and Organic Pollutants Associated with Use of Coal as a Fuel

(Completion rept.)

Manahan, Stanley E.

Missouri Water Resources Research Center, Columbia.

Sponsor: Office of Water Research and Technology, Washington, D.C.

Report No.: W76-01688; OWRT-B-110-MO(1)

21 Aug 75 40p

NTIS Prices: PC A03/MF A01 Journal Announcement: GRAI7604

Contract No.: DI-14-31-0001-4170; OWRT-B-110-MO

Cation exchangers were prepared by surface oxidizing Missouri bituminous coal with 6 M nitric acid through which air was bubbled. This treatment introduces oxygen-containing functional groups on the coal surface producing an ion exchanger with acid-base properties and the capability of chelating metal ions. The sodium form of the ion exchanger removed sulfuric acid from water raising the pH from 1.5 to more than 8. Ferrous iron at 25 mg/l in pH 1.5 sulfuric acid (simulating acid mine water) was removed to less than 0.2 mg/l by the sodium form of the ion exchanger. A similar solution of ferric iron was lowered from 100 mg/l to about 0.5 mg/l by the same treatment. The treated coal was found to chemically reduce some iron (III) to iron (II). When passed over the acid form of the coal ion exchanger, copper and cadmium levels in neutral solution were lowered from 10 mg/l to 0.01 and 0.00 mg/l, respectively, and from 50 mg/l to 0.02 and 0.01 mg/l respectively. The low ion exchange capacity of surface treated coal limits its usefulness in treating water. Base-soluble coal humic acid has a much higher ion exchange capacity, and work is continuing on its use for wastewater treatment.

481437 PB-247 282/7

Summary of Ground-Water Quality Impacts of Uranium Mining and Milling in the Grants Mineral Belt, New Mexico

(Technical note (final))

Kaufmann, Robert F. ; Eadie, Gregory G. ; Russell, Charles R.

Office of Radiation Programs, Las Vegas, Nev.

Report No.: ORP/LV-75-4

Aug 75 81p

NTIS Prices: PC A05/MF A01 Journal Announcement: GRAI7604

Ground-water contamination from uranium mining and milling results from the infiltration of radium-bearing mine, mill, and ion-exchange plant effluents. Radium, selenium, and nitrate were of most value as indicators of contamination. In recent years, mining has increased radium in mine effluents from several picocuries/liter (pCi/l) or less, to 100-150 pCi/l. The shallow aquifer in use in the vicinity of one mill was grossly contaminated with selenium, attributable to the mill tailings. Seepage from two other mill tailings ponds averaged 67,400,000 liters/year and, to date, has contributed an estimated 1.1 curies of radium to ground water. At one of these, an injection well was used to dispose of over 3,400,000,000 liters of waste from 1960-1973. The wastes have not been properly monitored and have apparently migrated to more shallow, potable aquifers. No adverse impacts on municipal water quality in Paguate, Bluewater, Grants, Milan, and Gallup were observed.

479623 PB-246 023/6

Long Shield Mining Method

(Patent)

Oudenhoven, Martin S.

Department of the Interior, Washington, D.C.

Corp. Source Codes: 109950

Report No.: PAT-APPL-456 509; PATENT-3 892 076

Filed 1 Apr 74 patented 1 Jul 75 7p

Also includes report no. DOCKET/MIN-2138.

Government-owned invention available for licensing. Copy of patent available Commissioner of Patents, Washington, D.C. 20231 $0.50.

Document Type: Patent

NTIS Prices: Not available NTIS Journal Announcement: GRAI7603

The patent describes a long shield mining backfill method that conveys and then compresses the processed waste material from a mined out area, like wetted spent oil shale, behind a shield until a predetermined high pressure is detected. Once detected, lower pressure compressors are actuated to move the shield away from the waste material surface. Next, this operation is repeated beginning with filling the material under low pressure compression between the mine wall and new shield position. Thereafter, high pressure compression takes place again until a predetermined high pressure is detected. Then, as before, low pressure compression is activated to free the shield. This same sequence can be repeated as many times as desired at different cut levels. The principle object of the patent is an improved method of backfilling waste material in a mined out area.

477501 PB-246 046/7
Geochemical and Sedimentological Analysis of Tygart Lake, West Virginia
Collin, Martin L.
West Virginia Univ., Morgantown. Water Research Inst.
Sponsor: Office of Water Research and Technology, Washington, D.C.; West Virginia Univ., Morgantown. Dept. of Geology.
Report No.: WRI-WVU-75-02; BULL-3-3; W76-00376; OWRT-A-009-WVA(1)
Sep 75 49p
NTIS Prices: PC A03/MF A01 Journal Announcement: GRAI7602
Contract No.: OWRT-A-009-WVA

The study was directed toward obtaining a clearer understanding of the sediment environment of Tygart Lake, a U. S. Army Corps of Engineers reservoir. The reservoir water is acid. Turbulence and total solids were found to be low. The sediment contained clay in proportions varying from 4.1 to 18.3% of the total. All parameters of the sedimentary clay exhibited clear patterns of lateral change from the dam toward the Tygart Valley River inlet, and with depth from the sediment-water interface to the base of the sampled core. For loss on ignition, cation exchange capacity, clay content, and the cations of nitrogen, phosphorus, calcium, iron, and magnesium, a decrease in percentages or absolute amounts were detected laterally from the dam toward the Tygart Valley River inlet, and an increase was observed with depth in the sediment profile. For silicon, aluminum, and potassium cations, the patterns were reversed, so that increases were noted laterally from the dam toward the river inlet, and decreases were marked with depth in the sediment profile. Kaolinite, illite, vermiculite and minor amounts of montmorillonite were present. Further year-round study of the geochemistry of several limnic basinal areas will be required to verify any general occurrence of patterns of pollutant accumulation within clay sediment.

472393 PB-245 130/0
Underground Disposal of Coal Mine Wastes
National Academy of Sciences-National Academy of Engineering, Washington, D.C. Environmental Studies Board.
Report No.: ISBN-0-309-02324-6
Mar 75 184p
Library of Congress Catalog Card no. 74-32597
Paper copy available from National Academy of Sciences, 2101 Constitution Ave., Washington, D.C. 20418. PC$6.25.
NTIS Prices: MF A01 Journal Announcement: GRAI7525
Contract No.: NSF-C310

The report assesses the technological and economic feasibility of underground refuse disposal in the context of the full resource problem, considering the subsequent effect on the underground mining environment, costs and benefits as compared to other options, legal parameters, and related health factors. Considerations include safety of miners, groundwater contamination, backfilling methods, and losses in productivity. Existing legislation for coal mine waste disposal is reviewed. Tables and figures augment the text.

467871 NTIS/PS-75/714/6
Acid Mine Drainage (A Bibliography with Abstracts)
(Rept. for 1964-Aug 75)
Brown, Robena J.
National Technical Information Service, Springfield, Va.
Corp. Source Codes: 391812
Sep 75 155p
Supersedes NTIS/PS-75/046.
Document Type: Bibliography
NTIS Prices: PC N01/MF N01 Journal Announcement: GRAI7523

The bibliography on acid mine drainage cites studies primarily concerning control and treatment methods. Also included are reports on hydrogeology, ecology, formation, and sources. (Contains 150 abstracts).

463758 PB-243 740/8
The Use of Waste and Low-Grade Materials in Road Construction: 2. Colliery Shale
Sherwood, P. T.
Transport and Road Research Lab., Crowthorne (England).
Report No.: TRRL-LR-649
1975 25p
NTIS Prices: PC A02/MF A01 Journal Announcement: GRAI7521

The use of lower-grade and waste materials as alternatives to naturally occurring aggregates in the construction of roads helps to conserve the supplies of good quality aggregates and assists in problems arising from the disposal of unwanted materials. This Report is one of a series that is aimed at bringing together the information that is available on each of the major waste products that have roadmaking potential. It deals with colliery shale and it considers the extent to which shale can be used in road construction. The Report discusses the types and quantity of shale that are available, the purposes to which it can be put in the various stages of road construction and the tests needed to ensure that shales meet the required specifications.

463720 PB-243 652/5

Limited Field Tests in Electrokinetic Densification of Mill Tailings

(Rept. of investigations Jul 72-Jul 73)

Sprute, R. H. ; Kelsh, D. J.

Bureau of Mines, Spokane, Wash. Spokane Mining Research Center.

Corp. Source Codes: 390057

Report No.: BUMINES-RI-8034

Jun 75 52p

NTIS Prices: PC A04/MF A01 Journal Announcement: GRAI7521

Extensive laboratory testing has shown that electrokinetic densification can be an effective method for dewatering and consolidating unclassified metal mine mill tailings. This report describes results of a limited field test of this technique. Eighteen-cubic-yard concrete model stopes, 18 feet long by 6 feet deep by 56 inches wide, were filled with unclassified tailings slurry from a metal mine in the Coeur d'Alene, Idaho, district. Five different tests were performed. They showed that a strong, dense, dewatered fill can be obtained in a reasonably short timeusing electrokinetics, with typical power consumption of 25 to 30 kilowatt-hours per cubic yard of densified fill. At present power costs in the Coeur d'Alene district, this would amount to 10 to 12 cents per cubic yard.

463588 ORNL-TM-4903-VOL-1

Correlation of Radioactive Waste Treatment Costs and the Environmental Impact of Waste Effluents in the Nuclear Fuel Cycle for Use in Establishing As Low As Practicable Guides-Milling of Uranium Ores

Sears, M. B. ; Blanco, R. E. ; Dahlman, R. C. ; Hill, G. S. ; Ryon, A. D.

Oak Ridge National Lab., Tenn.

Corp. Source Codes: 263050

May 75 331p

See also ORNL-TM-4902.

NTIS Prices: PC A15/MF A01 Journal Announcement: GRAI7521

Contract No.: W-7405-eng-26

A cost-benefit study was made to determine the cost and effectiveness of radioactive waste (radwaste) treatent systems for decreasing the release of radioactive materials from model uranium ore processing mills, and to determine the radiological impact (dose commitment) of the release materials on the environment. Additional radwaste treatment techniques are applied to the base case mill and the waste tailings area in a series of case studies to decrease the radiological dose commitment to the population in the surrounding area. The cost for the added waste treatment operations and the corresponding dose commitment are calulated for each case.

459535 PB-242 908/2

Water Quality Control in Mine Spoils Upper Colorado River Basin

(Environmental Protection technology series)

McWhorter, David B. ; Skogerboe, Rodney K. ; Skogerboe, Gaylord V.

Colorado State Univ., Fort Collins.

Corp. Source Codes: 088300

Sponsor: National Environmental Research Center, Cincinnati, Ohio.

Report No.: EPA/670/2-75-048

Jun 75 110p

NTIS Prices: PC A06/MF A01 Journal Announcement: GRAI7519

Contract No.: EPA-R-802621; EPA-ROAP-21BDU-02

The purpose of the study was to identify potential water quality problems associated with runoff and percolation through mine spoils at selected sites in the Upper Colorado River Basin. The results show that the production of soluble salts from mine spoils into receiving waters is probably the most significant water quality problem that can be expected. No significant release of heavy metals was observed in the coal mine spoils studied. Some significant heavy metal concentrations were observed in the stream below the tailings disposal area from a copper-lead-zinc mill. A portion of these metals are contributed by the tailings, but a variety of old mines and mine dumps also make a contribution. The quality of percolate and runoff from spoils was found to correspond to the constituents of extracts prepared from saturated pastes of the spoil material. A method of estimating salt production into receiving waters was derived and found to agree very well with measured salt pickup at one coal site. The minimum quantities of salts that will eventually be released from the spoils studied are estimated.

457949 PB-242 860/5
Ground Water Pollution Problems in the Northwestern United States
van Der Leeden, Frits ; Cerrillo, Lawrence A. ; Miller, David W.
Geraghty and Miller, Inc., Port Washington, N.Y.
Sponsor: Environmental Protection Agency, Corvallis, Oreg.
Report No.: EPA-660/3-75-018
May 75 378p
NTIS Prices: PC A17/MF A01 Journal Announcement: GRAI7518
Contract No.: EPA-68-03-0298; EPA-ROAP-21AIO-005

An evaluation of ground-water problems has been carried out in six states in the northwest: Colorado, Idaho, Montana, Oregon, Washington and Wyoming. There is a need for baseline water quality data and systematic evaluation of overall ground-water conditions, especially in urban zones, in areas of petroleum exploration and development, and at locations of mining and industrial activity. The most common natural ground-water quality problems, other than high salinity, are excessive hardness, iron, maganese, and fluoride. Principal sources of man-caused ground-water quality problems in the approximate order of severity are: discharge of effluent from septic tanks and sewage treatment plants, irrigation return flow, dryland farming, abandoned oil wells, shallow disposal wells, unlined surface impoundments, mine tailings and mine drainage, municipal and industrial landfills, and radioactive waste disposal. Other sources that appear to be of less importance but still must be considered include: spills and leaks, application of fertilizers and pesticides, feedlots, and salt-water intrusion.

457896 PB-242 721/9
Determination of Estimated Mean Mine Water Quantity and Quality from Imperfect Data and Historical Records
(Final rept)
Environmental Quality Systems, Inc., Washington, D.C.
Sponsor: Appalachian Regional Commission, Washington, D.C.
Report No.: ARC-72-108/RPC-728
Jan 73 176p
NTIS Prices: PC A09/MF A01 Journal Announcement: GRAI7518

The report is one of a series dealing with different aspects of environmental pollution in the Monongahela River Basin. The purpose of the study on which this report is based was to develop a methodology determining this increase or decrease and the sources of pollution when complete data is not available. Special attention was given to acid mine drainage.

457847 PB-242 610/4
Mine Drainage Pollution Watershed Survey. Cherry Creek, Casselman River Watersheds, Garrett County, Maryland
(Final rept)
Maryland Dept. of Natural Resources, Annapolis. Program Planning and Evaluation.
Sponsor: Skelly and Loy, Harrisburg, Pa.; Appalachian Regional Commission, Washington, D.C.; Baker-Wibberley and Associates, Inc., Hagerstown, Md.
Report No.: ARC-72-47-May-73
May 73 417p
NTIS Prices: PC A18/MF A01 Journal Announcement: GRAI7518
Contract No.: ARC-42-47/RP-228

The purpose of the project was to perform a detailed study which would develop and recommend an abatement plan designed to eliminate the deleterious effects of mine drainage pollution within the designated study areas. The study was performed within a framework of a logical series of phases and milestone goals. These were (1) collect and review data, (2) reconnaissance, (3) one-year control sampling (4) field explorations, (5) subsurface explorations, (6) interpret aquatic biota study, (7) mine development drawing, (8) evaluate sources and abatement measures. It was concluded that Cherry Creek is the most polluted stream, unfortunately, from natural sources more than mine drainage. It was recommended that emergency engineering design of the abatement plan be implemented at once. Color illustrations reproduced in black and white.

454243 PB-242 341/6
Distribution, Cultivation and Chemical Destruction of 'Gallionella' from Alabama Ground Water
(Master's thesis)
Christian, Jr, Robert D.
Alabama Univ., Birmingham.
Corp. Source Codes: 387757
Sponsor: Office of Water Research and Technology, Washington, D.C.
Report No.: W75-08479; OWRT-B-045-ALA(1)
1975 159p
Document Type: Thesis
NTIS Prices: PC A08/MF A01 Journal Announcement: GRAI7516
Contract No.: DI-14-31-0001-3855; OWRT-B-045-ALA

Results of hydrogeologic and microbiologic studies were combined to determine the ecology of the iron bacteria, Gallionella, in water systems in Alabama and to find a chemical cure for water wells contaminated with this organisms. Treatment of laboratory strains of Gallionella with disinfectants indicated that a chemical cure is possible; however, only field experiments can determine if permanent cures occur. Success in the future will probably depend on the effectiveness of quaternary ammonium compounds which have several advantages over chlorine compounds.

448902 PB-241 215/3
Prompt Copper Recovery from Mine Strip Waste
(Rept. of investigations)
Madsen, B. W. ; Groves, R. D. ; Evans, L. G. ; Potter, G. M.
Bureau of Mines, Salt Lake City, Utah. Salt Lake City Metallurgy Research Center.
Report No.: BUMINES-RI-8012
Mar 75 25p
NTIS Prices: PC A02/MF A01 Journal Announcement: GRAI7514

In conventional dump leaching of sulfide waste, generally less than one-quarter of the copper is extracted. Gold, silver, and molybdenum that may be present in the dump are not recovered. Much of the sulfides in mine strip waste occurs along natural fracture planes. Some of these sulfides are liberated with enrichment of the fines fraction when the waste is broken during mining or in subsequent crushing. In research to take advantage of such enrichment, the treatment of three sulfide copper mine stripping waste samples was investigated by sizing or by crushing and sizing, followed by floatation of the enriched fines and leaching the remaining coarse rock. In the treatment of a chalcocite-bearing monozite mine waste sample, as much as 35 percent of the copper, 38 percent of the molybdenum, and 19 percent of the silver originally in the waste were recovered by floatation of the fines. An additional 33 percent of the copper was recovered by leaching the coarse fraction for 500 days.

441745 PB-240 022/4
Physical Property Data on Coal Waste Embankment Materials
(Rept. of investigations Jan-Jun 73)
Busch, Richard A. ; Backer, Ronald R. ; Atkins, Lynn A.
Bureau of Mines, Spokane, Wash. Spokane Mining Research Center.
Corp. Source Codes: 390057
Report No.: BUMINES-RI-7964
Nov 74 149p
NTIS Prices: PC A07/MF A01 Journal Announcement: GRAI7511

Engineering design criteria for coal refuse embankments have been totally lacking and have created hazardous impoundment structures in coal mining areas. A necessary first step to develop design criteria is the determination of basic representative physical property data on the materials that constitute typical refuse embankments. An extensive field and laboratory program was undertaken by the U.S. Bureau of Mines Spokane Mining Research Center. Much physical property data was generated. Additional petrographic analysis and large scale triaxial compression testing was performed by others. The data presented here should be extremely valuable in establishing design parameters for coal refuse embankments.

440393 PB-240 686/6
The Florida Phosphate Slimes Problem--A Review and a Bibliography
Bureau of Mines, Tuscaloosa, Ala. Tuscaloosa Metallurgy Research Lab.
Report No.: BUMINES-IC-8668
Jan 75 46p
Paper copy also available from SOD as stock number 2404-01718.
Document Type: Bibliography
NTIS Prices: PC A03/MF A01 Journal Announcement: GRAI7512

The Florida phosphate industry, which supplies about three-fourths of the domestic phosphate fertilizer, produces tremendous volumes of phosphatic clay wastes (slimes). These clays retain a high percentage of water for extended periods of time. The clays also pose an environmental hazard because the disposal technique involves above-ground storage behind earthen dams. Although much research has been undertaken by numerous organizations to dewater slime, no completely satisfactory solution has been developed. In June 1972, a cooperative effort by the U.S. Bureau of Mines and the Florida phosphate mining industry was initiated to develop a solution for dewatering the Florida phosphatic slimes. This report discusses various aspects of the slimes problem, reviews past research, makes recommendations for future research and includes a bibliography of references and patents dealing with the subject.

440136 PB-240 355/8
The Use of Waste and Low-Grade Materials in Road Construction: 1. Guide to Materials Available
Sherwood, P. T.
Transport and Road Research Lab., Crowthorne (England).
Report No.: TRRL-LR-647
1974 16p
NTIS Prices: PC A02/MF A01 Journal Announcement: GRAI7512

A considerable amount of work has been done on the utilization of waste materials in road construction but the information so obtained is scattered among a large number of publications. The main purpose of this Report is to bring this information together so that an assessment can readily be made of the suitability of any particular waste material for roadmaking. The Report therefore considers the extent to which the road construction industry can use low-grade and waste material. It discusses the types and quantities of each material that are available, the purpose to which each material can be put in the various stages of road construction and the tests needed to ensure that the materials meet the required specifications. Materials discussed include: colliery shale, spent oil shale, wastes from coal-fired power stations, quarry wastes, chalk, incinerator waste, and blastfurnace and steel slags.

435638 NTIS/PS-75/112/3
Coal Mine Waste (A Bibliography with Abstracts)
(Rept. for 1964-Oct 1974)
Smith, Mona F.
National Technical Information Service, Springfield, Va.
Jan 75 56p
Document Type: Bibliography
NTIS Prices: PC N01/MF N01 Journal Announcement: GRAI7506

This bibliography contains 51 selected abstracts of research reports retrieved using the NTIS on-line search system--NTISearch. The topics cover all aspects of coal mining refuse and refuse dumps.

430972 NTIS/PS-75/046/3
Acid Mine Drainage (A Bibliography with Abstracts)
(Rept. for 1964-Oct 74)
Lehmann, Edward J.
National Technical Information Service, Springfield, Va.
Jan 75 142p
Document Type: Bibliography
NTIS Prices: PC N01/MF N01 Journal Announcement: GRAI7506

All aspects of mine acid drainage are covsred in 137 abstracts. Primarily they cover control and treatment techniques; however, also included are studies on the ecological effects, sources, and formation.

420231 PB-236 989/0
Seepage-Environmental Analysis of the Slime Zone of a Tailings Pond
(Rept. of investigations)
Kealy, C. Daniel ; Busch, Richard A. ; McDonald, Michael M.
Bureau of Mines, Spokane, Wash. Spokane Mining Research Center.
Corp. Source Codes: 390057
Report No.: BUMINES-RI-7939
Sep 74 95p
NTIS Prices: PC A05/MF A01 Journal Announcement: GRAI7426

The principal contribution of this research is to identify the influences of the slime zone in preventing their reaching the environment outside the tailings pond. The finite-element method has been used to determine the rate of discharge of subsurface water from the Van Stone tailings pond in northern Washington. The slime zone was sampled and tested for the first time and results interpreted and incorporated into the mathematical model. Computer results were verified by installing and monitoring piezometers in the field; and by a simulated (16- by 1/2- by 3-foot) laboratory model. Minimization of seepage requires maintaining the pond water over the slime zone.

420013 PB-236 528/6
Neutralization of Ferrous Iron-Containing Acid Wastes
(Patent)
Cywin, Allen
Environmental Protection Agency, Washington, D.C.
Corp. Source Codes: 390139
Report No.: PAT-APPL-33 455; PATENT-3 617 559
Filed 30 Apr 70 patented 2 Nov 71 4p
Government-owned invention available for licensing. Copy of patent available Commissioner of Patents, Washington, D.C. 20231 $0.50.
Document Type: Patent
NTIS Prices: Not available NTIS Journal Announcement: GRAI7426

The patent describes the neutralization of acid waste waters containing ferrous iron using limestone in a finely divided state. Substantial amounts of a mixed valence, hydrous iron oxide sludge are recycled back to the neutralization and aeration steps of the process to produce a dense, easily dewaterd sludge having improved handling characteristics.

414426 PB-235 929/7
An Evaluation of Tailings Ponds Sealants
(Environmental Protection technology series)
Clark, Don A. ; Moyer, James E.
Robert S. Kerr Environmental Research Lab., Ada, Okla.
Sponsor: National Environmental Research Center, Corvallis, Oreg.
Report No.: W74-12217; EPA-660/2-74-065
Jun 74 35p
Paper copy available from GPO.
NTIS Prices: PC-GPO/MF A01/NTIS Journal Announcement: GRAI7424
Contract No.: EPA-21AGF-16

A summary is presented of the rather limited information available in the literature pertaining to the use of sealants for mine and mill tailings ponds. Included is a discussion of currently employed seepage detection methods, as well as the various types of sealants currently in use--compacted earth, clays, chemicals, waste tailings solids, asphalt, and synthetic membranes. Only properly installed synthetic liners will prevent all seepage. Installation costs of the sealants, including labor, are discussed and graphs for estimating costs based on pond size are presented. Regulations governing the amount of seepage allowed are ill-defined or non-existent in the majority of states.

410337 PB-234 607/0
Limestone and Limestone-Lime Neutralization of Acid Mine Drainage
(Final rept.)
Wilmoth, Roger C.
Environmental Protection Agency, Rivesville, W. Va. Crown Mine Drainage Control Field Site.
Report No.: EPA-670/2-74-051
Jun 74 101p
Paper copy available from GPO.
NTIS Prices: PC-GPO/MF A01-NTIS Journal Announcement: GRAI7422

The critical parameters affecting neutralization of ferric-iron acid mine waters were characterized by the U.S. Environmental Protection Agency in comparative studies using hydrated lime, rock-dust limestone, and a combination of the two as neutralizing agents. The advantages and disadvantages of each of these neutralizing agents were noted. On the ferric-iron test water, combination limestone-lime treatment provided a better than 25-percent reduction in materials cost as compared to straight lime or limestone treatment. Significant reduction in sludge production was noted by the use of rock-dust limestone and by the use of combination treatment as compared to hydrated-lime treatment. Emphasis on optimizing limestone utilization efficiencies resulted in an increase from approximately 35-percent to 50-percent utilization. Studies using limectone that had been ground to pass a 400-mesh screen resulted in utilization efficiencies near 90 percent.

410261 PB-234 062/8
Laboratory Experiments in Electrokinetic Densification of Mill Tailings. 2. Application to Various Types and Classifications of Tailings
(Rept. of investigations)
Sprute, R. H. ; Kelsh, D. J.
Bureau of Mines, Washington, D.C.
Corp. Source Codes: 068450
Sponsor: Bureau of Mines, Spokane, Wash. Spokane Mining Research Center.
Report No.: BUMINES-RI-7900
Jun 74 50p
See also PB-234 049. Prepared by Spokane Mining Research Center, Wash.
NTIS Prices: PC A03/MF A01 Journal Announcement: GRAI7422

This report describes Bureau of Mines laboratory test results in electrokinetic dewatering and consolidation of metal-mine mill tailings from five mines in the Coeur d'Alene, Idaho district. Classified (coarse) tailings, slimes, and unclassified material were separately tested. Tailings were placed in 0.3-cubic foot plexiglass models and dc potential applied until dewatering ceased. Time-oriented measurements of water removal, changes in resistivity, and power consumption were recorded during the dewatering process. Moisture content and density of the dewatered material at test end indicated the method to be generally effective for all materials examined, but best results were achieved with well-mixed unclassfied tailings.

405816 PB-234 180/8
Storage and Disposal of Iron Ore Processing Wastewater
(Environmental protection technology series)
Baillod, C. Robert ; Alger, George R.
Michigan Technological Univ., Houghton. Dept. of Civil Engineering.
Report No.: W74-10193; EPA-660/2-74-018
Mar 74 142p
Paper copy available from GPO $1.80.
NTIS Prices: PC-GPO/MF A01-NTIS Journal Announcement: GRAI7420
Contract No.: EPA-14040-FVD

The study was concerned with the handling of wastewater resulting from the concentration of low grade iron ore. Specific objectives were to develop tailings basin design and management criteria, to investigate methods of treating basin effluents, and to investigate transport characteristics of particulate materials contained in basin discharges. These objectives were accomplished through laboratory and field studies conducted at the tailings impoundment systems associated with two iron ore concentrating plants located in Upper Michigan. Annual water balances were formulated for the tailings system at each plant to show the relative importance of precipitation, surface outflow and seepage. Settling column and dye dispersion tests were employed to predict concentrations of suspended material remaining in basin effluents. The cost effectiveness of various coagulation systems for treating basin effluent was investigated. Particular attention was devoted to a study of the thickening and dewatering characteristics of the slurry produced by chemical coagulation of the basin effluent. Finally, settling column experiments in which fine tailings particles were diluted with various natural waters were conducted.

404072 PB-234 049/6
Laboratory Experiments in Electrokinetic Densification of Mill Tailings. 1. Development of Equipment and Procedures
(Rept. of investigations)
Sprute, R. H. ; Kelsh, D. J.
Bureau of Mines, Washington, D.C.
Corp. Source Codes: 068490
Report No.: BUMINES-RI-7892
Jun 74 80p
Prepared by Spokane Mining Research Center, Wash. See also PB-234 062.
NTIS Prices: PC A05/MF A01 Journal Announcement: GRAI7419

This report describes Bureau of Mines laboratory test results in electrokinetic dewatering and consolidation of metal-mine mill tailings. Tailings were placed in 0.3 cu ft plexiglass models and dc potential applied until dewatering ceased. Time-oriented measurements of water removal, changes in resistivity, and power consumption were recorded during the dewatering process. Dewatered material was tested for moisture content and density. Equipment and procedures were developed to optimize the method for unclassified mill tailings from a particular mine in the Coeur d'Alene, Idaho district. Results indicate the method to be highly effective in dewatering and consolidating this material.

401934 PB-233 738/4
Reconnaissance Survey Report of Coal-Mine Refuse Dumps and Impoundments. Volume 6. State of West Virginia
(Final rept)
Wahler (W.A.) and Associates, Palo Alto, Calif.
Report No.: DI-MESA-74-001-6
Feb 74 312p
Paper copy also available from NTIS $25.00/set of 6 reports as PB-233 732-SET.
NTIS Prices: PC A14/MF A01 Journal Announcement: GRAI7418
Contract No.: S0122084

A reconnaissance level investigation of 49 representative coal mine refuse dump and impoundment sites was conducted during the spring of 1972 in West Virginia to determine the size, shape, and nature of the coal waste problem and to develop ways of identifying potential hazards. The study was completed by this compilation of individual site data and summary information concerning all sites within the State. Each individual site report contains information on the ownership, location, dimensions, history, geology, hydrology, coal seam mined, type of mining, preparation plant process and equipment, materials involved, and rates of disposal. In addition, aerial and ground photographs depict significant features of each site.

401933 PB-233 737/6
Reconnaissance Survey Report of Coal-Mine Refuse Dumps and Impoundments. Volume 5. State of Virginia
(Final rept)
Wahler (W.A.) and Associates, Palo Alto, Calif.
Report No.: DI-MESA-74-001-5
Feb 74 146p
Paper copy also available from NTIS $25.00/set of 6 reports as PB-233 732-SET.
NTIS Prices: PC A07/MF A01 Journal Announcement: GRAI7418
Contract No.: S0122084

A reconnaissance level investigation of 14 representative coal mine refuse dump and impoundment sites was conducted during the spring of 1972 in Virginia to determine the size, shape, and nature of the coal waste problem and to develop ways of identifying potential hazards. The study was completed by this compilation of individual site data and summary information concerning all sites within the State. Each individual site report contains information on the ownership, location, dimensions, history, geology, hydrology, coal seam mined, type of mining, preparation plant process and equipment, materials involved, and rates of disposal. In addition, aerial and ground photographs depict significant features of each site.

401932 PB-233 736/8
Reconnaissance Survey Report of Coal-Mine Refuse Dumps and Impoundments. Volume 4. State of Pennsylvania
(Final rept)
Wahler (W.A.) and Associates, Palo Alto, Calif.
Report No.: DI-MESA-74-001-4
Feb 74 197p
Paper copy also available from NTIS $25.00/set of 6 reports as PB-233 732-SET.
NTIS Prices: PC A09/MF A01 Journal Announcement: GRAI7418
Contract No.: S0122084

A reconnaissance level investigation of 24 representative coal mine refuse dump and impoundment sites was conducted during the spring of 1972 in Pennsylvania to determine the size, shape, and nature of the coal waste problem and to develop ways of identifying potential hazards. The study was completed by this compilation of individual site data and summary information concerning all sites within the State. Each individual site report contains information on the ownership, location, dimensions, history, geology, hydrology, coal seam mined, type of mining, preparation plant process and equipment, materials involved, and rates of disposal. In addition, aerial and ground photographs depict significant features of each site.

401929 PB-233 733/5
Reconnaissance Survcy Report of Coal-Mine Refuse Dumps and Impoundments. Volume 1. State of Alabama
(Final rcpt)
Wahler (W.A.) and Associates, Palo Alto, Calif.
Report No.: DI-MESA-74-001-1
Feb 74 106p
Paper copy also available from NTIS $25.00/set of 6 reports as PB-233 732-SET.
NTIS Prices: PC A06/MF A01 Journal Announcement: GRAI7418
Contract No.: S0122064

A reconnaissance level investigation of five representative coal mine, refuse dump and impoundment sites was conducted during the spring of 1972 in Alabama to determine the size, shape, and nature of the coal waste problem and to develop ways of identifying potential hazards. The study was completed by this compilation of individual site data and summary information concerning all sites within the State. Each individual site report contains information on the ownership, location, dimensions, history, geology, hydrology, coal seam mined, type of mining, preparation plant process and equipment, materials involved, and rates of disposal. In addition, aerial and ground photographs depict significant features of each site.

399682 PB-233 026/4
Analysis of Pollution Control Costs
Doyle, Frank J. ; Bhatt, Harasiddiprasad G. ; Rapp, John R.
Appalachian Regional Commission, Washington, D.C.
Report No.: EPA-670/2-74-009
Feb 74 421p
Prepared by Michael Baker, Jr., Inc., Beaver, Pa.
NTIS Prices: C A18/MF A01 Journal Announcement: GRAI7417
Contract No.: EPA-14010-HQC

This report fulfills requirements for an effective, workable handbook on pollution control costs and factors effecting these costs for the Monongahela River Basin. The information is based on the latest technological developments and cost analyses of recent reclamation projects. Although the report was developed for the Monongahela River Basin study, the cost estimates and supporting data should prove useful for all of Appalachia and other areas with similar topography, coal mine drainage pollution problems and mining history. Specific areas covered are surface mines, refuse piles, mine sealing, mine drainage treatment, air pollution control, solid waste handling and disposal, abandoned automobiles, and erosion and sedimentation control.

399884 PB-232 764/1
Electrochemical Removal of Heavy Metals from Acid Mine Drainage
(Environmental protection technology series)
Franco, Nicholas B. ; Balouskus, Robert A.
Ecotrol, Inc., Columbia, Md.
Report No.: EPA-670/2-74-023
May 74 97p
NTIS Prices: PC A05/MF A01 Journal Announcement: GRAI7417
Contract No.: EPA-14010-GAD

Laboratory and field studies were conducted to determine the economics of ferrous iron oxidation in a cell containing a bed of conductive particles in the space between the cathode and the anode. The effects of the process on other heavy metals present in acid mine drainage (AMD) and on the character of solids precipitated during treatment of low acidity water were also observed. A 18.9 liter/min (5 gal./min) pilot plant was operated at an actual mine site to evaluate treatment of 40 and 250 ppm ferrous iron AMD at pH levels of 2 and 5. A conventional aeration system was also included to generate comparative data. Estimates for a 473 liter/min (125 gal./min) plant based on the pilot data for oxidation only indicate that capital and operating costs for electrochemical treatment would be higher than those for aeration by factors of 5 and 1.7 respectively. (Modified author abstract)

387696 PB-232 449/9
Application of Reverse Osmosis to Acid Mine Drainage Treatment
(Environmental protection technology series (Final))
Wilmoth, Roger C.
Environmental Protection Agency, Riversville, W. Va. Crown Mine Drainage Control Field Site.
Report No.: EPA-670/2-73-100; W74-08155
Dec 73 171p
Paper copy available from GPO $2.00 as stock no. EP1.23:670/2-73-100.
NTIS Prices: PC-GPO/MF A01-NTIS Journal Announcement: GRAI7416
Contract No.: EPA-14010-TMC

Spiral-wound reverse osmosis systems were tested on acid mine drainage discharges whose water quality characteristics were quite varied. In addition, comparison studies were made of the hollow-fiber and tubular systems and of the spiral and hollow-fiber systems. At all sites, the limiting factor in high recovery operation was calcium sulfate insolubility. Product water was of near potable quality. Neutralization was required in all cases to elevate pH and, in some cases, to remove residual iron and manganese. A 'neutrolosis' process was developed in the course of these investigations and constituted a major technological advance in reverse osmosis treatment of acid mine drainage. The neutrolosis process, a combination of reverse osmosis and neutralization, achieved water recoveries near 99 percent while producing a high quality product. Pretreatment consisted of ten micron filtration. Ultraviolet disinfection, acid injection, or both, were sometimes necessary to inhibit iron oxidation and precipitation.

389269 PB-231 249/4
An Appraisal of Neutralization Processes to Treat Coal Mine Drainage
(Environmental protection technology series)
Lovell, Harold L.
Pennsylvania State Univ.. University Park. Coll. of Earth and Mineral Sciences.
Corp. Source Codes: 405416
Report No.: W74-08512; EPA-670/2-73-093
Nov 73 364p
Paper copy available from GPO $3.50/ as stock no EP1.23:670/2-73-093.
NTIS Prices: PC-GPO/MF A01 Journal Announcement: GRAI7412
Contract No.: EPA-14010-EFN

Four different quality drainages were treated and detailed results tabulated. Appropriate unit operations, from water collection to sludge disposal were considered for eight different reagents (calcium/magnesium carbonate, oxide and hydroxide; caustic soda and soda ash). Necessary process variations were possible with a versatile 500,000 gpd facility. Limestone has the least cost per neutralization equivalent and may be used with drainage containing up to 500 mg/l iron II. The resulting sludge is dense, rapid settling and dewaterable. Thickeners are preferred to settling lagoons to separate sludge in larger plants. Dewatered sludge requires least disposal volume.

383676 PB-229 649/9
The Microbiology of Acid Mine Water Treatment in Packed Bed Columns
(Research publication no. 77)
Unz, R. F. ; Lieberman, M. T.
Pennsylvania State Univ., University Park. Inst. for Research on Land and Water Resources.
Report No.: W74-05409; OWRR-A-024-PA(1)
Dec 73 82p
NTIS Prices: PC A05/MF A01 Journal Announcement: GRAI7410
Contract No.: DI-14-31-0001-4038; OWRR-A-024-PA

The present research was undertaken in an effort to identify the agents responsible for the transformation of ferrous iron to the ferric state during application of acid mine water to columns of trickling filter medium located in the bed of a full scale trickling filter.

373470 PB-227 342/3
Feasibility Study Lake Hope Mine Drainage Demonstration Project
Ohio Dept. of Natural Resources, Columbus.
Report No.: EPA-R2-73-151
Mar 73 98p
Paper copy available from GPO $1.25 as EP1.23/2: 73/151.
NTIS Prices: PC-GPO/MF A01-NTIS Journal Announcement: GRAI7406
Contract No.: EPA-14010HJQ

The Lake Hope project will demonstrate the control and elimination of mine drainage pollution by refuse pile disposal and/or covering and underground mine sealings. Acid producing coal refuse will be removed and buried in suitably prepared sites. These sites will be finished graded and seeded. Non-acid producing coal mine refuse piles will be reshaped to existing contours, covered and reclaimed by appropriate seeding and tree planting for erosion control and aesthetic enhancement. The mine sealing demonstration program will be undertaken in two phases. The first phase will seal those mine openings, which have been determined the most significant acid discharges and those openings immediately adjacent to or suspected of having connecting with the high acid concentration discharge openings. The second phase will seal selected remaining mine openings as determined by the continuous water quality monitoring data obtained. Continuous water quality monitoring systems will obtain data to be evaluated over the life of the project and after all construction has been completed.

373324 PB-226 995/9
Water Quality Considerations for the Metal Mining Industry in the Pacific Northwest
Sceva, Jack E.
Environmental Protection Agency, Seattle, Wash. Region X.
1973 91p
NTIS Prices: PC A05/MF A01 Journal Announcement: GRAI7406

The report describes the principal causes of water pollution at both active and abandoned mines and provides suggestions and recommendations for minimizing the effects of mining on water quality. Part 1 of the report discusses problems related to the exploration and development of a mineral deposit, the mining of the ore and control of mine drainage, the milling of ore, and the construction and operation of tailings ponds. The water pollution problems associated with abandoned mines are discussed in Part 2 and items relating to the construction of mine roads are given in Part 3.

371820 PB-226 615/3
Factors Controlling Sludge Density During Acid Mine Drainage Neutralization
(Completion rept.)
Svanks, K. ; Shumate, K. S.
Ohio State Univ., Columbus. Water Resources Center.
Report No.: 392X; W74-02827; OWRR-A-022-OHIO(1)
Oct 73 156p
NTIS Prices: PC A08/MF A01 Journal Announcement: GRAI7405
Contract No.: OWRR-A-022-OHIO

Laboratory scale experiments were employed to investigate the feasibility of coal mine drainage neutralization treatment with the formation of magnetite and other high density/low volume sludges. Where applicable, the effects of bacterial catalysis on ferrous iron oxidation were incorporated into the the investigations. Major process types studied included magnetite formation, and high density sludge from lime treatment of acid mine drainage. Both acidic iron solutions and synthetic acid mine drainage were studied, primarily in batch process reaction systems, both with and without sludge recycle. Emphasis was placed on development of a basic understanding of the results observed, and interpretations draw heavily on both experimental results and an incisive literature review.

360066 PB-224 594/2
Recommended Methods of Reduction, Neutralization, Recovery, or Disposal of Hazardous Waste. Volume XV. Research and Development Plans
(Final rept.)
Ottinger, R. S. ; Blumenthal, J. L. ; Dal Porto, D. F. ; Santy, M. J.
TRW Systems Group, Redondo Beach, Calif.
Corp. Source Codes: 354595
Report No.: TRW-21485-6013-RU-00-VOL-15; EPA-670/2-73-053-o
Aug 73 109p
Paper copy also available from NTIS $72.00/set of 16 reports as PB-224 579-SET.
NTIS Prices: PC A06/MF A01 Journal Announcement: GRAI7324
Contract No.: EPA-68-03-0089

This volume presents more detailed information for some of the projects proposed and summarized in Chapter 6 of Volume I. The projects described herein include cementation processes, both inorganic and organic, sulfur sequestering, arsenic removal from soil, recovery of alumina from clay and sulfur oxide scrubbing wastes, characterization of incineration parameters for the safe disposal of pesticides, new chemical concepts for use of waste pesticides, and isolation of mercury and other heavy metals from dilute waste streams.

360065 PB-224 593/4
Recommended Methods of Reduction, Neutralization, Recovery, or Disposal of Hazardous Waste. Volume XIV. Summary of Waste Origins, Forms, and Quantities
(Final rept.)
Ottinger, R. S. ; Blumenthal, J. L. ; Dal Porto, D. F. ; Gruber, G. I. ; Santy, M. J.
TRW Systems Group, Redondo Beach, Calif.
Corp. Source Codes: 354595
Report No.: TRW-21485-6013-RU-00-VOL-14; EPA-670-2-73-053-n
Aug 73 160p
Paper copy also available from NTIS $72.00/set of 16 reports as PB-224 593-SET.
NTIS Prices: PC A08/MF A01 Journal Announcement: GRAI7324
Contract No.: EPA-68-03-0089

This volume provides information on the origins, forms, and quantities of 13 groups of hazardous waste stream constituents, including pesticides, mercury and mercury compounds, arsenic and arsenic compounds, cadmium and cadmium compounds, lead compounds, soluble copper compounds, selenium and selenium compounds, boron hydrides, chromium compounds, inorganic cyanides, hydrofluoric and fluoboric acids, specific organic chemicals, explosive propellant and chemical warfare material and radioactive material. Separate reports on paint wastes and wastes from battery manufacture and the electroplating industry are also presented.

359425 COM-73-11800/2
Land Reclamation in Mining Areas. A Bibliography with Abstracts
(Rept. for 1964-May 73)
Ringe, Axel C.
National Technical Information Service, Springfield, Va.
Report No.: NTIS-WIN-73-077
Nov 73 30p
Supersedes NTIS-PK-32.
Document Type: Bibliography
NTIS Prices: PC E10/MF E10 Journal Announcement: GRAI7324

The NTISearch bibliography contains 25 selected abstracts of research reports retrieved using the NTIS on-line search system--NTISearch. Cited reports include research on techniques for the reclamation of land by revegetation and control of acid mine drainage in strip mine, spoil bank and tailings areas. (Author)

348091 PB-222 936/7
Combined Treatment of Municipal Wastewater and Acid Mine Drainage
(Research publication no. 73)
Pearson, Frank H. ; Nesbitt, John B.
Pennsylvania State Univ. University Park. Inst. for Research on Land and Water Resources.
Report No.: W73-13656; OWRR-B-042-PA(1)
Dec 72 50p
NTIS Prices: PC A03/MF A01 Journal Announcement: GRAI7320
Contract No.: DI-14-31-0001-3636; OWRR-B-042-PA

Acid mine drainage (AMD), a serious water pollutant in many states, may be an economical source of ferrous iron for the chemical coagulation of municipal wastewater. AMD would then be neutralized by the alkalinity in wastewater. Samples of AMD and raw wastewater were collected from sites in Pennsylvania where AMD was found close to a wastewater treatment plant. The samples were mixed in varying ratios, then processed at controlled pH in a laboratory scale treatment plant that provided flocculation and sedimentation. The optimal pH was 8 for a maximum reduction in phosphorus, ferrous iron, and turbidity. At pH 8 the median reduction in total phosphorous was 95 percent when the molar ratio of ferrous iron to total phosphorous was 2. Ferrous iron was almost completely removed at pH 8. A cost analysis is given for the maximum distance for which it is economical to pump AMD for combined treatment with wastewater. (Modified author abstract)

347756 PB-222 419/4
Studies on Modifications of Solid Industrial Wastes
(Final rept.)
Grove, C. S. ; Antoni, C. M.
Syracuse Univ., N.Y. Dept. of Civil Engineering.
Corp. Source Codes: 339710
Report No.: EPA-670/2-73-065
1973 179p
NTIS Prices: PC A09/MF A01 Journal Announcement: GRAI7320
Contract No.: EP-00257

The report consists of papers prepared for the series. 'Studies on Modifications of Solid Industrial Wastes.' Topics included were: collection and analysis of data on solid industrial wastes; physical properties of Solvay industrial waste bed materials; rehabilitation of solid industrial waste disposal sites; rehabilitation of the Solvay process waste beds; modifications of Solvay process solid waste disposal; inhibition of acid mine drainage by municipal solid waste effluents; use of solid industrial wastes in the preparation of construction materials; and effect of humus matter on retention of nitrogen fertilizers in soils.

346264 PB-222 463/2
Factors Controlling Copper (II) Concentrations in the Keweenaw Waterway
(Project completion rept.)
Leddy, David G.
Michigan Technological Univ., Houghton. Dept. of Chemistry and Chemical Engineering.
Report No.: W73-13010; OWRR-A-065-MICH(1)
29 Jun 73 115p
NTIS Prices: PC A06/MF A01 Journal Announcement: GRAI7319
Contract No.: DI-14-31-0001-3822; OWRR-A-065-MICH

The occurrence of copper (II) in the Keweenaw Waterway, Michigan from past use of the waterway as a dumping basin for copper-bearing mine tailings is a matter of concern because of the toxic effects of copper (II) on aquatic organisms. From 1972 to the present soluble copper as well as several other cations and anions were monitored at varying depths in water exposed to mine tailings. The study attempts to describe the most important factors involved in the water chemistry of copper in the waterway. A model proposed as a description of soluble copper concentration control predicts Cu(+2), CuCO3 (soluble), CuOH+, and Cu (organic) to be the principal copper species in solution. Cu (organic) is at times equal to 50 per cent of the total dissolved copper. (Modified author abstract)

340744 PB-221 337/9
Evaluation of Pollution Abatement Procedures, Moraine State Park
(Environmental protection technology series)
Foreman, John W. ; McLean, Daniel C.
Gwin, Dobson and Foreman, Inc., Altoona, Pa.
Report No.: EPA-R2-73-140; W73-11062
Jan 73 77p
Paper copy available GPO $1.00 as EPI.23/2.
NTIS Prices: PC-GPO/MF A01-NTIS Journal Announcement: GRAI7316
Contract No.: EPA-14010-DSC

Various mine drainage pollution abatement techniques completed during the construction phase of the Moraine State Park, Pennsylvania are evaluated. The remedial methods employed included strip mine reclamation, underground mine sealing, grouting, surface sealing, refuse pile removal, and oil and gas well plugging. The major objective of the pollution abatement project was to insure good water quality in Lake Arthur. This was achieved; the water quality in the lake from the time of its initial inundation in 1969 to the present has had a range in analysis as follows: pH: 6.0 to 7.6, alkalinity 10 to 96 ppm, acidity: 0 to 6 ppm, iron: 0.2 to 3.0 ppm and manganese: 0 to 3.5 ppm. (Modified author abstract)

332703 PB-219 826/5
Treatment of Ferrous Acid Mine Drainage with Activated Carbon
(Environmental protection technology series)
Ford, Charles T. ; Boyer, James F.
Bituminous Coal Research, Inc., Pittsburgh, Pa.
Report No.: W73-08296; EPA-R2-73-150
Jan 73 127p
Paper copy available from GPO $2.10 as EP1.23/2:73-150.
NTIS Prices: PC-GPO/MF A01-NTIS Journal Announcement: GRAI7313
Contract No.: EPA-14010-GYH

Laboratory studies were conducted with activated carbon as a catalyst for oxidation of ferrous iron in coal mine water. Batch tests and continuous flow tests were conducted to delineate process variables influencing the catalytic oxidation and to determine the number and types of coal mine water to which this process may be successfully applied. The following variables influence the removal of iron with activated carbon: (1) amount and particle size of the carbon; (b) pH, flow rate, concentration of iron, temperature, and total ionic strength of the water; and (c) aeration rate. Adsorption as well as oxidation are the mechanisms involved in iron removal by this process. An evaluation of this process indicated technical feasibility which would permit acid mine drainage neutralization using an inexpensive reagent, such as limestone. (Author Modified Abstract)

331019 PB-217 486
Determination of Mine Waste Acidity
Salotto, B. V. ; Barth, E. F. ; Ettinger, M. B. ; Tolliver, W. E.
Federal Water Pollution Control Administration, Cincinnati, Ohio.
Corp. Source Codes: 388275
Jan 67 27p
NTIS Prices: PC A03/MF A01 Journal Announcement: D7301

Pollution from acid mine drainage is a chronic problem. The current vigorous interest has led to a re-examination of the methods of measuring total acidity, which are clearly based on the limited laboratory capabilities of prior years. Defined acid-metal mixtures containing iron(III), aluminum(III), iron(II), and hydrogen ion were reacted with sodium hydroxide under varying titration conditions. Results showed that at 25C a reliable measure of the total acidity can be obtained by oxidizing iron(II) with hydrogen peroxide and stopping the titration at pH 7.3. Hydroloysis of Fe(III) and Al(III) was complete at pH 7.3 before formation of aluminate ion. Positive interference due to manganese and hardness can be held to a minimum by proper selection of sample volume. Acidity due to carbon dioxide is easily removed by aeration. The procedure was applied to the analysis of acid mine sample with added standards with recoveries of 98 to 103%. (Author)

330852 PB-216 865
Disposal of Chemical Sludges and Brines
Dean, Robert B.
Robert A. Taft Water Research Center, Cinicnnati, Ohio. Advanced Waste Treatment Research Lab.
May 70 10p
Presented at the Symposium on Coal Mine Drainage Research (3rd) Held at Mellon Inst., Pittsburgh, Pa., 19-20 May 70. Sponsored in part by the Ohio River Valley Water Sanitation Commission.
NTIS Prices: PC A02/MF A01 Journal Announcement: D7301
The disposal of pollutants in mine drainage is difficult because they are diluted with so much water. Sale of extracted pollutants is not economical. Acid can be neutralized but sulfates are left in solution. Iron can be precipitated but the precipitate is one of the most difficult to dewater. Ultimate disposal of solids will be to the land, either in dumps or spread thinly on pasture or woodland. Brines too strong to be accepted in surface waters must go to permanent storage or to the ocean. The paper has reviewed available processes for dealing with mine drainage and points out difficulties and advantages associated with them. (Author)

330389 PB-216 359
Reverse Osmosis Treatment of Concentrated Ferrous Iron Acid Mine Drainage
Wilmoth, Roger C. ; Scott, Robert B.
Federal Water Quality Administration, Norton, W. Va. Norton Mine Drainage Field Site.
Aug 70 16p
NTIS Prices: PC A02/MF A01 Journal Announcement: D7301
A 4,000 gpd reverse osmosis unit was tested on a severely polluted ferrous iron acid mine discharge near Morgantown, West Virginia. The water recovery rate was limited to fifty percent due to membrane fouling problems. The role of ferrous iron fouling could not be identified because of a predominance of calcium sulfate precipitation on the membranes. The feasibility of reverse osmosis treatment is doubtful for mine drainage having concentrations of acidity, iron, sulfate, and calcium as high as 5,000 mg/l, 2,300 mg/l, 10,000 mg/l and 525 mg/l, respectively, due to the membrane fouling problem, maximum recoveries of only 50 percent, and the non-potable quality of the product water. (Author)

329555 PB-202 571
Evaluation of a New Acid Mine Drainage Treatment Process
Black, Sivalls and Bryson, Inc., Pittsburgh, Pa. Applied Technology Div.
Report No.: W71-11795; EPA-WQO-14010-DYI-02/71
Feb 71 162p
Paper copy available from GPO $1.50 as stock no. 5501-0075.
NTIS Prices: PC-GPO/MF A01 Journal Announcement: D7301
Contract No.: DI-14-12-529; EPA-WQO-14010-DYI
An economic and engineering evaluation of a submerged coal refuse combustion process to convert acid mine water (AMW) to potable water has been made. In this process coal refuse is burned in molten iron to supply energy for distillation or reverse osmosis, and the coal refuse sulfur is trapped in a slag for evantual recovery of sulfur. Laboratory experimentation was conducted on those areas which could profoundly affect the process. These areas were: A laboratory demonstration of slag desulfurization to produce sulfur, the evaluation of slag retention characteristics, slag capability for neutralizing AMW and determination of slag compositions having acceptable fluidities. Engineering studies show that the process has potential for supplying inexpensive energy for distillation and permits the recovery of sulfur so that distilled water is economically produced. (Author Modified Abstract)

323965 PB-217 872/1
Effect of Strip Mining on Water Quality
(Project completion rept.)
Vimmerstedt, J. P. ; Finney, J. H. ; Sutton, P.
Ohio State Univ., Columbus. Water Resources Center.
Report No.: 330X; W73-06515; OWRR-B-002-OHIO(1)
Jan 73 64p
Prepared in cooperation with North Appalachian Experimental Watershed, Agricultural Research Service, Cashocton, Ohio.
NTIS Prices: PC A04/MF A01 Journal Announcement: GRAI7310
Contract No.: DI-14-01-0001-841; OWRR-B-002-OHIO
The report deals with two separate topics, the effect of strip-mining on water quality of Little Mill Creek, Ohio, and infiltration of water on strip-mine spoil banks. Chemical water quality in Little Mill Creek was measured for 236 weeks. Two of four sampling points received effluent from a coal strip mine. Sulfate, manganese, calcium, magnesium, iron, aluminum, and hydrogen ion concentrations were determined Rainfall infiltration on graded spoil banks, measured with a sprinkling infiltrometer, averaged about 1.5 cm per hour. Differences in moisture content, slope, bulk density, and texture of the spoil did not explain most of the difference in infiltration between spoils.

323842 PB-216 801/1
Aquatic-Biotic Community Structure as an Indicator of Pollution
Dills, Gary G. ; Rogers, Jr, David T.
Geological Survey of Alabama, University.
Report No.: CIRC-80; W73-06018; OWRR-A-022-ALA(1)
1972 31p
NTIS Prices: PC A03/MF A01 Journal Announcement: GRAI7310
Contract No.: DI-14-31-0001-3201; OWRR-A-022-ALA

Generally aquatic systems exposed to environmental stress (pollution) have fewer species and less diversity than naturally occurring communities. In the present study physicochemical conditions and community structure of benthic macroinvertebrates were investigated in a drainage system polluted with acid mine drainage. A statistical interpretation was preformed to show possible correlation between water parameters and species diversity. The applicability of using the macroinvertebrate community structure to evaluate stream conditions consequent to acid flow is discussed.

321410 PB-216 184/2
Cycling and Control of Metals
Curry, Marion G. ; Gigliotti, Gilbert M.
National Environmental Research Center, Cincinnati, Ohio.
Corp. Source Codes: 39C50
Report No.: NERC-C-CP-73-1
Feb 73 187p
Proceedings of an Environmental Resources Conference, Columbus, Ohio. 31 Oct-2 Nov 72. Sponsored in part by Environmental Protection Agency, Washington, D.C., National Science Foundation, Washington, D.C. and Battelle Columbus Labs., Ohio.
Document Type: Conference proceeding
NTIS Prices: PC A09/MF A01 Journal Announcement: GRAI7309

The problems of metals and their relationships to the environment are reported. The source of trace metals in the environment, their transport and effects, control processes, monitoring, and economic and legal aspects are among the topics discussed.

316625 PB-214 593/6
Removal of Dissolved Contaminants from Mine Drainage
Miller, Jan D.
Utah Univ., Salt Lake City.
Corp. Source Codes: 362900
Report No.: EPA-R2-72-130
Dec 72 61p
Paper copy available from GPO $1.25 as EP1.23/2: 72-130.
NTIS Prices: PC-GPO/MF A01-NTIS Journal Announcement: GRAI7307
Contract No.: EPA-14010-FKX

Eleven mill tailing samples from locations throughout the Rocky Mountain region were tested for their effectiveness in removal of dissolved contaminants from mine drainage. The average capacity of the tailings tested was 9.8 mg of iron per gram of tailing with a range of capacities from 6 mg/g to 15 mg/g. From these studies it was concluded that for almost all tailing samples, removal was accomplished mainly due to hydrolytic adsorption of metal ions with a small contribution due to the inherent basicity of the tailing. In the other case, removal occurred via reaction with calcareous components of the sample. Continuous column, or stationary bed tests, in the laboratory and in the field were not nearly as effective. It appears that for effective removal a stirred tank reactor will be required.

314756 PB-214 455/8
Oxidation of Pyrites in Chlorinated Solvents
(Environmental protection technology series)
Boros, Joseph A. ; Brenneman, Donald R. ; Troy, Joseph C.
NUS Corp., Pittsburgh, Pa. Cyrus Wm. Rice Div.
Report No.: EPA-R2-72-069
Nov 72 54p
Paper copy available from GPO $1.00 as EP1.23/2:72-069.
NTIS Prices: PC-GPO/MF A01-NTIS Journal Announcement: GRAI7306
Contract No.: EPA-14010-FMM

The purpose of the study was to develop methods for extracting sulfur and iron compounds from pyritic waste materials, producing a final refuse that is incapable of causing water pollution, and at the same time, conserving useful mineral resources. The primary method under investigation was the chlorination of pyrites in non-aqueous solvents. An attractive feature of the proposed method was its cyclic nature. Test results indicated that the successful extraction of sulfur and iron compounds depended upon the continuous addition of chlorine gas to the system. The expected replacement of chlorine by ferric chloride and sulfur dichloride was not achieved under conditions of the study. Recycling solvents through beds of pyrite, elevated temperatures, and treatment in ultra-violet radiation yielded slight improvements in reaction rate.

310263 PB-213 777/0

Combination Limestone-Lime Treatment of Acid Mine Drainage

Wilmoth, Roger C. ; Scott, Robert B. ; Hill, Ronald D.

Environmental Protection Agency, Cincinnati, Ohio.

27 Apr 72 23p

Presented at the Symposium on Coal Mine Drainage Research, (4th), Pittsburgh, Pa., 27 Apr 72. Prepared in cooperation with Norton Mine Drainage Field Site, W. Va.

NTIS Prices: PC A02/MF A01 Journal Announcement: GRAI7304

The research investigated treatment methods for ferric iron acid mine drainage. One of the most promising techniques studied was combination limestone-lime neutralization. To date, neutralization has been shown to be the most economical treatment method to remove iron, aluminum, and acidity. Lime treatment has received the majority of research attention. However, limestone treatment offers several distinct advantages over lime; namely higher density, lower volume sludges, cheaper raw material costs, easier handling. Conversely, the biggest disadvantages to limestone are its relatively inefficient reaction rate. In an effort to cover a broader spectrum of application, the report discusses the combination of the two processes.

310239 PB-213 752/9

Report on Pollution Affecting Water Quality of the Cheyenne River System, Western South Dakota

National Field Investigations Center-Denver, Colo.

Sep 71 99p

NTIS Prices: PC A05/MF A01 Journal Announcement: GRAI7304

During the summer of 1970, fish from the Cheyenne River Arm of Oahe Reservoir, and other areas throughout western South Dakota were found to have mercury in their flesh exceeding 0.5 parts per million (ppm). The report presents a follow up study to investigate the effects of natural mercury deposits throughout the Cheyenne River system in western South Dakota; to determine the location and extent of reservoirs of mercury and other toxic materials due to previous mining activity; to document and characterize the discharge of tailings solids and various dissolved toxic pollutants from the Homestake Mining Company Deadwood-Lead mill; and to ascertain the movement and fate of these pollutants in the hydrologic environment, and the effect of these pollutants on the biota.

310208 PB-213 721/7

Treatment of Ferrous Iron Acid Mine Drainage by Reverse Osmosis

Wilmoth, Roger C. ; Mason, Donald G. ; Gupta, Mahendra

Environmental Protection Agency, Norton, W. Va. Norton Mine Drainage Field Site.

1972 42p

Presented at the Symposium on Coal Mine Drainage Research (4th), Pittsburgh, Pa., 26 Apr 72. Prepared in cooperation with Rex Chainbelt, Inc., Milwaukee, Wis.

NTIS Prices: PC A03/MF A01 Journal Announcement: GRAI7304

In previous research, reverse osmosis treatment of a ferrous iron mine discharge at Mocanaqua, Pennsylvania was studied. Using a tubular system, a loss of 90 percent of the original product flow in 400 hours of operation due to iron fouling was observed. Though sodium hydrosulfide flushes were successful in flux restoration, fouling immediately recurred upon resumption of operation on the ferrous water. To investigate the Mocanaqua fouling phenomena, field studies were undertaken. Reported are the results of the tests and comparisons with a spiral wound and hollow fiber reverse osmosis unit studied at the same time.

310177 PB-213 690/4

Neutrolosis Treatment of Acid Mine Drainage

Hill, Ronald D. ; Wilmoth, Roger C. ; Scott, Robert B.

Robert A. Taft Water Research Center, Cincinnati, Ohio.

Report No.: EPA-WQO-14010-05/71

1971 14p

NTIS Prices: PC A02/MF A01 Journal Announcement: GRAI7304

The report summarizes recent research on the treating of acid mine drainage. Two processes are combined. Reverse osmosis is used followed by cycling the resulting brine through a neutralization plant. The clarified water from here is then blended into the reverse osmosis feed. The process extracts 98 plus percent of the water and produces a sludge suitable for disposal through landfill.

306330 PB-213 121/7
Purification of Mine Water by Freezing
(Water pollution control research series)
Applied Science Labs., Inc., State College, Pa.
Corp. Source Codes: 032300
Report No.: W73-01817; EPA-14010-DRZ-02/71
Feb 71 65p
Paper copy available from GPO $0.70 as EP1.16:14010DRZ02/71.
NTIS Prices: PC-GPO/MF A01-NTIS Journal Announcement: GRAI7302
Contract No.: EPA-14010-DRZ

Partial freezing of acid mine water was used to the extent of 50% conversion to ice. Various metal and acid components in the product water were consistently reduced 85 to 90%. Acid mine water that had been treated with lime was used in similar freezing experiments and observed to have a reduction of metal ions. The pH remained substantially unchanged and the hardness of the water was reduced by nearly 100%. Considerable variations resulted even with efforts toward good control and reproducibility of operation. A firm conclusion as to reduction of sulfate and reduction of certain individual metals was prevented because of difficulties with analytical results. (Author)

305271 PB-213 042/5
Concentrated Mine Drainage Disposal into Sewage Treatment Systems
Environmental Research and Application, Inc., Wilton, Conn.
Report No.: W73-01639; EPA-14010-FBZ-09/71
Sep 71 81p
Paper copy available from GPO $0.75 as stock no. EP1.16:14010-FBZ-09/71.
NTIS Prices: PC A05GPO/MF A01-NTIS Journal Announcement: GRAI7202
Contract No.: EPA-14010-FBZ

Studies were undertaken on a small scale to determine the effect liquid waste artificial iron-rich acid brines had on municipal sewage treatment processes. The brines were devised to simulate concentrates from treatment of acid mine drainage. At very high concentrations, the brines neutralized with lime give virtually complete removal of phosphate from primary effluent, activated sludge effluent, or anaerobic sludge digester decantate. The cost of the iron-rich acid brine produced from acid mine drainage by the reverse osmosis membrane treatment is estimated. Costs of transportation by rail, truck, and pipeline are also shown. (Author)

294284 AD-749 409
Advances in Solid Waste Treatment Technology
(Research rept.)
Hershaft, Alex
Grumman Aerospace Corp Bethpage N Y Research Dept
Corp. Source Codes: 406165
Aug 72 79p
NTIS Prices: PC A05/MF A01 Journal Announcement: GRAI7222

The report presents a critical survey of recent advances in solid waste treatment technology and directs the reader's attention to the definitive sources of information in this area. Specific topics covered include storage, removal, transportation, fragmentation, sorting, bulk reduction, conversion, reclamation, and disposal. (Author)

285715 PB-211 020
Reverse Osmosis Demineralization of Acid Mine Drainage
(Water pollution control research series)
Rex Chainbelt, Inc., Milwaukee, Wis. Ecology Div.
Report No.: W72-11598; EPA-14010-FQR-03/72
Mar 72 113p
Paper copy available from GPO $1.00 as EP2.10:14010 FQR 03/72.
NTIS Prices: PC-GPO/MF A01-NTIS Journal Announcement: GRAI7218
Contract No.: EPA-14010-FQR

A two-phase study, involving both laboratory and field investigations, has demonstrated the feasibility of using reverse osmosis to provide potable water from acid mine drainage. The laboratory investigations involved the determination of methods for controlling iron fouling and the selection of a process flow sheet. During the field test, the process developed in Phase I was used to treat acid mine drainage from an underground abandoned anthracite coal mine. Treatment prior to reverse osmosis consisted of filtration (10 microns) followed by ultraviolet light disinfection. Brine from the RO unit was treated by neutralization, oxidation, and settling. Results obtained indicated that membrane fouling due to iron was satisfactorily controlled, but calcium sulfate fouling limited the recovery of product water to about 75%. Product water was of potable quality in all respects except for iron, manganese, and pH. Calcium sulfate precipitate on the RO membrane was successfully removed using a solution of ammoniated citric acid at pH 8. (Author)

271985 PB-208 820
Electrochemical Treatment of Acid Mine Waters
(Water pollution control research series)
Tyco Labs., Waltham, Mass.
Corp. Source Codes: 355550
Report No.: W72-07799; EPA-14010-FNQ-02/72
Feb 72 89p
Paper copy available from GPO $1.00 as EP2.10:14010FNQ.
NTIS Prices: PC-GPO/MF A01-NTIS Journal Announcement: GRAI7212
Contract No.: EPA-14-12-859; EPA-14010-FNQ

Synthetic acid mine drainage (AMD) water was prepared by draining tap water through waste coal, and the resulting AMD was treated on a laboratory scale by an electrolytic oxidation process. Tests of fluidized bed, packed-bed, and annular flow prototype reacotrs demonstrated the packed-bed reactor to be most efficient. Oxidation of Fe(2+) to Fe(3+) takes place on a carbon electrode at a mass transport limited rate, while hydrogen evolution occurs on a polished 316 stainless steel cathode, limited by a slower electrochemical kinetic step. Preliminary economic analyses, using a packed-bed reactor are given. The electrolytic process is free from both the safety hazards associated with radio isotope-induced oxidation and the temperature dependence of biological oxidation methods. (Author)

269292 PB-208 411
Foam Separation of Acid Mine Drainage
(Water pollution control research series)
Horizons, Inc., Cleveland, Ohio.
Report No.: W72-07102; EPA-14010-FUI-10/71
Oct 71 61p
NTIS Prices: PC A04/MF A01 Journal Announcement: GRAI7211
Contract No.: EPA-14-12-876; EPA-14010-FUI

Laboratory studies of continuous flow foam separation were conducted to determine the optimum conditions for maximum extraction of dissolved metal cations (Fe, Ca, Mg, Mn, and Al) from acid mine drainage. Foaming experiments were conducted in a 6 in.-diameter glass column capable of liquid flow rates of 3-12 gal. per hour. The approach to foam separation taken was the production of the persistent foams which allowed protracted foam drainage to reduce liquid carry-over in the foam. The effects of pH, chelate addition, surfactant type and concentration, air sparging rate, metal concentration and foam drainage were investigated in relation to metal extration. Results show that sewage foamability is too low for foam separation alone to be a feasible sewage treatment method. (Author)

267417 PB-208 326
Studies of Limestone Treatment of Acid Mine Drainage. Part II
Bituminous Coal Research, Inc., Monroeville, Pa.
Report No.: W72-06849; EPA-14010-EIZ012/71
Dec 71 153p
Paper copy also available GPO $1.25 as EP2.10:14010 EIZ-12/71.
NTIS Prices: PC-GPO/MF A01-NTIS Journal Announcement: GRAI7210
Contract No.: EPA-14010-EIZ

Laboratory investigations have demonstrated the feasibility of using limestone in place of pure lime for treating acid mine drainage for the neutralization of acidity and removal of iron to acceptable limits. The process consists of: Equalization; Addition of pulverized limestone and mixing; Aeration; Slurry recirculation to the mixing area; Sludge settling; and Sludge dewatering and disposal. Total costs are given. Advantages and disadvantages of limestone cver lime are also discussed.

256949 PB-206 194
Control of Mine Drainage from Coal Mine Mineral Wastes. Phase I. Hydrology and Related Experiments
Barthauer, G. L. ; Kosowski, Z. V. ; Ramsey, J. P.
Truax-Traer Coal Co., Pinckneyville, Ill.
Report No.: W72-03785; EPA-WQO-14010-DDH-08/71
Aug 71 144p
Paper copy available from GPO $1.25 as EP2.10:14010DDH08/71.
NTIS Prices: PC-GPO/MF A01-NTIS Journal Announcement: GRAI7206
Contract No.: EPA-WQO-14010-DDH

A project has been underway which attempts to demonstrate practical means of abating pollution from coal mine mineral wastes. The site included a refuse pile occupying approximately 40 acres and a slurry lagoon complex of 50 acres. In the report, the characteristics and acid formation rate of the refuse pile are described. The average rate of acid formation for this refuse pile is 198 pounds of acidity, as $CaCO_3$, per acre per day. Acid contribution from the slurry lagoons was not determined but appears to be negligible. As an abatement measure, a number of experimental vegetative covers were tested. Grass was successfully established with and without the use of topsoil, weathering well for one year. The long-term effects of establishing a grass cover directly on the refuse without the use of topsoil are not known at this time. (Author)

249932 PB-204 889
Water Geochemistry of Mining and Milling Retention Ponds in the New Lead Belt of Southeast Missouri
(Completion rept. Jul 70-Jun 71)
Bolter, Ernst ; Tibbs, Nicholas H.
Missouri Water Resources Research Center, Rolla.
Report No.: W72-01692; OWRR-A-032-MO(1)
Sep 71 40p
NTIS Prices: PC A03/MF A01 Journal Announcement: GRAI7203
Contract No.: DI-14-31-0001-3225; OWRR-A-032-MO

The heavy metal content and other geochemical data of the mine and mill waters of two mining operations in the 'New Lead Belt' of southeastern Missouri were determined and the efficiency of retention ponds in reducing high metal concentrations was investigated. The mine waters from two mines of this mining district, which is the largest lead producer in the world, showed a heavy metal content of less than 6 ppb copper, 66 ppb lead and 37 ppb zinc. The heavy metal content from the mill effluents was reduced to values similar to mine water, when the pond sizes were large enough. The concentrations of calcium, magnesium sodium and potassium, and pH allow the tracing of mine water in the streams. The retention ponds are not entirely efficient in preventing transport of metal rich rockflower into the streams.

238951 PB-202 854
A Pre-Impoundment Ecological Study of the Benthic Fauna and Water Quality in the North Anna River
(Completion rept. Jul 69-Jun 71)
Simmons, Jr, George M.
Virginia Polytechnic Inst. and State Univ., Blacksburg. Water Resources Research Center.
Report No.: W71-12693; OWRR-A-031-VA(1)
Sep 71 11p
NTIS Prices: PC A02 MF A01 Journal Announcement: GRAI7121
Contract No.: OWRR-A-031-VA

Virginia Electric and Power Company is building a 13,000 acre impoundment on the North Anna River to provide cooling water for a 14,000,000 kilowatt nuclear powered electrical generating facility. A detailed two-year water quality study has been made of the pre-impoundment basin. Results show that much of the pre-impoundment basin has been damaged by erosion, heavy metals, and acid drainage from old pyrite mine tailings on Contrary Creek. The river, below the confluence with Contrary Creek, is in the process of biological recovery, but the molluscan species have failed to become re-established within the pre-impoundment area. Increased discharge rates due to rainfall also produced high coliform counts. Construction of the impoundment is expected to ameliorate the effects of acid drainage and high coliform counts and hasten the recovery of the North Anna River below the dam site. (Author)

(Research and development progress rept.)
Ahlgren, Richard A.
Aqua-Chem, Inc., Waukesha, Wis.
Report No.: OSW-PR-561
Oct 70 326p
Paper copy available from GPO $2.50/copy as I1.88:561.
NTIS Prices: PC-GPO/MF A01-NTIS Journal Announcement: GRAI7113
Contract No.: DI-14-01-0001-2103

A study was made of the technical and economic feasibility of using desalination methods and equipment for the recovery of materials from industrial plant waste streams. It was determined that a very substantial market for this equipment exists and that desalination technology can convert many waste disposal problems into paying recovery situations. It was estimated that over one billion dollars in desalination equipment could be utilized in various waste recovery and processing operations. The most promising industries are: SIC - Pulp and Paper; SIC 202 - Cheese and Dairy; SIC 3312 - Iron and Steel; SIC 347 - Plating and Metal Finishing; - Nuclear Power Plants; - Acid Mine Drainage. (Author)

216977 PB-198 225
Treatment Of Acid Mine Drainage by Ozone Oxidation
Beller, M. ; Waide, C. ; Steinberg, M.
Brookhaven National Lab., Upton, N.Y.
Corp. Source Codes: 064750
Report No.: W71-06250; EPA-WQO-14010-FMH-12/70
Dec 70 99p
Paper copy available from SOD $1.00 as EP 2.10:14010FMH12/70.
NTIS Prices: PC-SOD/MF A01-NTIS Journal Announcement: GRAI7111
Contract No.: DI-14-12-838; EPA-WQO-14010-FMH

An engineering design and economic study to evaluate the feasibility of ozone oxidation and limestone neutralization of Acid Mine Drainage (AMD) was performed. The study concludes that an ozone process is feasibile, compares economically with existing processes, and offers potential advantages in process control, reduced neutralization costs, and simplified AMD sludge handling and disposal. Ozone production by electric discharge and radiation processes are compared both for on-site and central plant installations utilizing ozone shipping and storage facilities. A central chemonuclear ozone production plant with a distribution system is found to be most economical, followed by electric discharge central and on-site plants. Design and construction of a mobile pilot plant which employs electric discharge ozonizers is recommended for field trials of the process. (Author)

215064 PB-198 042
Pollution from Mines in the 'New Lead Belt' of South Eastern Missouri
Wixson, Bobby G. ; Bolter, Ernst A. ; Tibbs, Nicholas H. ; Handler, Anthony R.
Missouri Univ., Rolla.
Corp. Source Codes: 400144
Report No.: W71-05837; OWRR-A-021-MO(2)
1969 27p

Also available as Rept. no. OWRR-B-021-MO(3). Presented at the Purdue Industrial Waste Conference 7 May 69. See also Rept. no. W71-04182.

NTIS Prices: PC A03 MF A01 Journal Announcement: GRAI7110
Contract No.: OWRR-A-021-MO; OWRR-B-021-MO

In the southeastern part of Missouri, the Clark National Forest straddles the Ozark Plateau and contains the headwaters of some of the most scenic rivers in the state. In 1955, rich mineral deposits were discovered in this area and by 1962 a rich lead-zinc ore belt was found to extend for approximately thirty-six miles almost due south from Viburnum, Missouri, through Iron and Reynolds Counties. The name given this new ore district was the Viburnum Trend or the 'New Lead Belt'. The report is concerned with the change of water quality and ecology of streams receiving the mining wastes. Heavy metal studies indicated that the range of values for copper, lead and zinc were from 1-20 ppb (parts per billion). The most frequently occurring values for all 3 elements were from 4-6 ppb. No significant changes in water quality were found for dissolved oxygen, alkalinity, hardness or stream temperature. Recommendations are presented for future stream pollution abatement in the 'New Lead Belt'. (WRSIC abstract)

209315 PB-197 531
Geochemical Effects of Mining Pollution on the Streams of Southeast Missouri
(Completion rept. Jul 69-Jun 70)
Bolter, Ernst ; Tibbs, Nicholas H.
Missouri Water Resources Research Center, Rolla.
Report No.: W71-04536; OWRR-A-023-MO(1)
Dec 70 26p
NTIS Prices: PC A03 MF A01 Journal Announcement: GRAI7107
Contract No.: DI-14-31-0001-3025; OWRR-A-023-MO

Streams in the 'New Lead Belt' of SE Missouri were analyzed for copper, lead and zinc. This area, is rapidly developing into the largest lead-zinc mining district of the United States. The data of the study were compared to the results of a pre-mining investigation to determine if the mining activity contributed to the pollution of the streams by heavy metals. Data from an individual mine indicate that the milling waste waters can increase the heavy metal content of the receiving stream up to seven times. However, the heavy metal content of the stream decreases to background concentrations within a distance of three miles. The summarized data of the total area do not indicate a noticeble increase of the heavy metal content in the streams. The average concentrations in the streams at the time of the present investigation were 5.3 ppb for copper, 8.9 ppb for lead and 9.5 ppb for zinc. The calcium content is in the range of 2.45 ppm. The magnesium content in the range of 1-30 ppm. The pH of the streams ranges ?rom 7.0-8.8. It is concluded, that the mining activity presently does not significantly pollute the streams with heavy metals. (Author)

209312 PB-197 528
The Impact of Lead-Zinc Mining on the Quality and Ecology of Surface Waters in Southeast Missouri
(Completion rept.)
Bolter, Ernst ; Tibbs, Nicholas H.
Missouri Water Resources Research Center, Rolla.
Report No.: W71-04537; OWRR-B-021-MO(2)
Dec 70 84p
See also Rept. no. W71-04536, PB-197 531.
NTIS Prices: PC A05 MF A01 Journal Announcement: GRAI7107
Contract No.: DI-14-01-0001-1520; OWRR-B-021-MO

The background concentrations were determined for copper, lead, and zinc in the streams of the Viburnum Trend or New Lead Belt of Southeast Missouri. Analytical methods were developed for atomic absorption spectroscopy. These methods initially consisted of coextraction of copper, lead, and zinc using the APDC/MIBK system, and finally of extraction of copper by APDC/MIBK and direct analysis of lead and zinc using the newly developed 'Sampling Boat' technique. The data obtained from these analyses were arranged in histograms and critically analyzed. The background concentrations were established to be 4-6 ppb for all three elements. Methods are presented for identifying both short term and long term contamination by using the data distributions. The data distributions were not useful for geochemical prospecting under the studied geological conditions. (Author)

209310 PB-197 526
Vascular Aquatic Plants in Acid Mine Water of the Monongahela River, West Virginia
Clarkson, Roy B. ; Moore, Jerry A.
West Virginia Univ., Morgantown. Water Research Inst.
Report No.: BULL-2; W71-04418; OWRR-A-005-WVA(3)
1971 13p
Pub as West Virginia Univ. Bull. Ser-71, no. 7-5 Jan 71.
NTIS Prices: PC A02 MF A01 Journal Announcement: GRAI7107
Contract No.: OWRR-A-005-WVA

A study of vascular aquatic plants in three West Virginia acid mine water polluted rivers-the Monongahela, Tygart Valley, and West Fork-found plants abundant in many areas. The most common species is Eleocharis acicularis (L.) R. and S. The next most abundant plants are Sagittaria graminea Michx., S. latifolia Willd., Potamogeton ephydrus Raf., P. nodosus Poir., Sparganium americanum Nutt., and Myriophyllum heterophyllum Michx. Six areas were chosen for intensive study. Water samples from each were analyzed chemically for nitrogen, phosphate, calcium, total acidity, iron and pH. Physical factors studied were the substrate, water velocity, and water-level fluctuation. From a stepwise discriminant analysis, substrate was determined to be the primary physical factor in determining plant distribution. Phosphate and water-level fluctuation were also significant. Nitrogen, calcium, total acidity, iron, pH, and water velocity were determined to be nonlimiting for the species studied. (Author)

209266 PB-197 471
Neutralization of High Ferric Iron Acid Mine Drainage
Wilmoth, Roger C. ; Hill, Ronald D.
Robert A. Taft Water Research Center, Cincinnati, Ohio.
Report No.: W71-04189; FWQA-14010-ETV-08/70
Aug 70 48p
See also report dated May 70, PB-192 087. Paper copy available from Superintendent of Documents, GPO, Washington, D.C. 20402, $0.50 as I67.13/4:14010ETV08/70.
NTIS Prices: PC S0D MF A01 Journal Announcement: GRAI7107
Contract No.: FWQA-14010-ETV

Lime, limestone, and soda ash were studied as neutralizing agents for treatment of a ferric iron acid mine drainage water. Both continuous flow and batch tests were used to determine the effectiveness of each of these neutralizing agents in reaction with acid mine water. Comparisons made between the three neutralizing agents include: chemical costs, reaction efficiencies, effluent water qualities, sludge settling rates, sludge volumes, and percent solids of sludges. All three neutralizing agents were capable of treating acid mine drainage. Lime costs were half that of limestone for treating the same acid mine drainage because of the low utilization of limestone. However, the characteristics of the limestone sludge were superior to those of lime and soda ash sludges. The cost for soda ash treatment was excessive. Further research on improving limestone utilization is under way. No difference in reaction efficiency were found in dry feeding or slurry feeding the neutralizing agents. Aeration during and/or after the limestone reaction merely increased the effluent pH but failed to increase limestone useage efficiency or improve effluent quality. (Author)

209265 PB-197 470
Treatment of Acid Mine Drainage
Bikerman, J. J. ; Hanson, P. J. ; Rose, S. H.
Horizons, Inc., Cleveland, Ohio.
Report No.: W71-04188; FWQA-14010-DEE-12/70
Dec 70 100p
Paper copy available from Superintendent of Documents, GPO, Washington, D.C. 20402. $1.00 as I67.13/4:14010DEE12/70.
NTIS Prices: PC S0D MF A01 Journal Announcement: GRAI7107
Contract No.: FWQA-14-12-496; FWQA-14010-DEE

Basic experiments were conducted to establish the feasibility of foam fractionation in the treatment of acid coal mine drainage for the removal of the metal ions iron, calcium, manganese and magnesium. The independent variables controlling foam separation of metal ions were determined to be the concentration ratio of surfactant to iron, the air volume throughput, the foam drainage time, the total dissolved salt content and the type of surfactant used. The major part of iron, calcium, manganese and magnesium can be foam separated from acid solution by proper control of the independent variables. Reduction of residual surfactant concentration in the treated water and reduction of water entrained with the foam are two areas in need of further investigation. Foam separation was tested on acid drainage, partially lime neutralized drainage and complete limestone neutralized drainage. Tests on model solutions indicate that treatment of raw acid drainage is most feasible at present. Operating and capital costs are estimated for 0.1 and 1.0 MGD batch treatment plants. (Author)

197563 PB-195 282
Studies on Limestone Treatment of Acid Mine Drainage
(Water pollution control research series)
Bituminous Coal Research, Inc., Monroeville, Pa.
Corp. Source Codes: 068470
Report No.: FWPCA-DAST-33; W71-00620; FWPCA-14010-EIZ-01/70
Jan 70 106p

Report on Optimization and Development of Improved Chemical Techniques for the Treatment of Coal Mine Drainage. Paper copy available from Superintendent of Documents, GPO, Washington, D.C. $1.25 as I67.13/4DAST33.

NTIS Prices: PC S00 MF A01 Journal Announcement: USGRDR7101

Contract No.: FWPCA-14010-EIZ; FWQA-63-01-68; FWPCA-14010-E-IZ

Four actual coal mine waters have been neutralized with limestone both on a batch scale and by utilizing a continuous flow apparatus. Variations in treatment procedure were necessary depending on the characteristics of the individual waters. A standardized test was established to evaluate the reactivity of the limestones. The following variables are of importance in evaluating limestones for coal mine water neutralization: (a) particle size, (b) Ca and Mg content, and (c) surface area. Ferrous iron oxidation has been accomplished with both synthetic and actual coal mine water at low pH in the presence of coal-derived activated carbon. Electrophoretic mobility studies on precipitates obtained by both lime and limestone neutralization of coal mine water yielded information which can be applied for more effective sludge removal. Magnetic sludges were prepared using two different iron-bearing waters. The conversion of precipitates to a magnetic form results in significant reductions in settled sludge volumes as well as increases in solids content. Data obtained in these studies indicate that the limestone process offers considerable promise for an improved lower cost method for treating several types of coal mine waters. (Author)

195923 PB-195 200
Treatment of Acid Mine Drainage by Reverse Osmosis
Rex Chainbelt, Inc., Milwaukee, Wis.
Corp. Source Codes: 403607
Report No.: FWPCA-14010-DYK-03/70; W71-00477
Mar 70 42p

Prepared in cooperation with the Commonwealth of Pennsylvania Department of Mines and Mineral Industries. Paper copy available from Superintendent of Documents, GPO, Washington, D.C. 20402. $0.55 as I67.13/4: 14010DYK03/70.

NTIS Prices: MF A01 Journal Announcement: USGRDR7024

Contract No.: FWPCA-14010-DYK

The report documents a study on the treatment of acid mine drainage by reverse osmosis. The objective of the study was to determine the feasibility of utilizing reverse osmosis to abate pollution due to acid mine drainage, and produce a water which could be used by industry or as a municipal water supply. A test site in Shickshinny, Pennsylvania was selected as a source of acid mine water for the study. A sample of this water was tested in a laboratory reverse osmosis unit to determine the design parameters for a 10,000 gallon per day demonstration unit. The results obtained during the demonstration period indicated that the reverse osmosis process has potential application in acid mine drainage treatment. A high quality water was produced which was suitable for use by industries or municipalities with a minimum of additional treatment. There are, however, operational problems which must be solved prior to utilizing reverse osmosis on a large scale. These include maintenance of high permeation rates through the membrane by reducing membrane fouling and determination of the optimum flow sheet for an acid mine treatment system utilizing reverse osmosis. (Author)

180990 PB-192 103
Biological Oxidation Rate in Mine Acid Water Regimes
(Research project technical completion rept.)
Kountz, R. Rupert ; Rosenberger, Lee ; Eberhardt, W. A.
Pennsylvania State Univ., University Park. Inst. for Research on Land and Water Resources.
Report No.: W69-08379; OWRR-A-001-PA(1)
30 Jun 69 31p

NTIS Prices: PC A03 MF A01 Journal Announcement: USGRDR7016

Contract No.: DI-14-01-0001-983; OWRR-A-001-PA

The velocity rate constants for biological oxidation were evaluated by employing synthetic sewage and laboratory simulated acid mine water regimes. Lowering of pH decreases the value of the rate constants until a maximum reduction of 65 percent is obtained at pH value of 4.0. Increasing concentrations of ferric ion cause a further, but small decrease in the rate constant. It was demonstrated that biological oxidation does occur in streams contaminated with acid mine drainage; consequently, the permissable discharge loadings can be calculated (by employing the reduced rate constants) either by manual computation, or the stream stretch can be developed with an analog computer programming. (WRSIC-abstract)

180974 PB-192 087
Neutralization of High Ferric Iron Acid Mine Drainage
Wilmoth, Roger C. ; Scott, Robert B.
Federal Water Quality Administration, Norton, W. Va. Norton Mine Drainage Field Site.
Report No.: W70-07149; FWQA-14010-06/70
19 May 70 28p
Presented at Symposium on Coal Mine Drainage Research (3rd), Pittsburgh, Pa. 19 May 70.
NTIS Prices: PC A03 MF A01 Journal Announcement: USGRDR7016

The Norton Mine Drainage Field Site of the Federal Water Quality Administration has been conducting research on the feasibility of acid mine drainage treatment using lime, limestone, and soda ash neutralization. The Norton research facility is located at Norton, West Virginia, on the banks of Grassy Run--a small, heavily polluted stream of which an estimated 90% of the water flow is from abandoned mines. Tests were run on identical samples of Grassy Run water to determine the quality of the supernatant when the sample was neutralized to various pH's. Lime, limestone, and soda ash were each tested as the neutralizing agents. All 3 neutralizing agents--lime, limestone, and soda ash--can meet the pH 6.5, net alkalinity, iron below 7.0 ppm criteria with relative ease. The major differences between soda ash neutralization and lime or limestone neutralization are that soda ash produces low hardness, low calcium, high sodium, and high cost, whereas all other chemical parameters are comparable between the 3 neutralizing agents. (WRSIC abstract)

177983 PB-191 481
An Investigation of Potential Interactions of Coal and Coal Products for Use in the Treatment of the Mine Drainage Waters
(Research project technical completion rept.)
Lovell, Harold L. ; Sloughfy, James L.
Pennsylvania State Univ., University Park. Inst. for Research on Land and Water Resources.
Report No.: W69-08466; OWRR-B-004-PA(1)
30 Jun 69 188p
Document Type: Thesis
NTIS Prices: PC A09 MF A01 Journal Announcement: USGRDR7014
Contract No.: OWRR-B-004-PA

The potential for using coal or coal-products (including commercial activated carbon) for treating mine water was considered. Certain coals whose inherent mineral matter have the capacity to reduce acidity are being employed industrially. Acidity reduction by the organic phases of coal is nil. Coal products heated to 450C in a nitrogen or steam atmosphere have a little acid-reduction response. Coal activated by steam at 800C develops increased specific surfaces, including complex carbon oxides which have the ability to reduce acidity. The properties of such products and commercial activated carbons may have potential in treating these and other polluted waters. (WRSIC abstract)

175352 PB-191 215
Effect of Antibacterial Agents on Mine Drainages. Use of Viable Antibacterial Agents to Reduce Pollution by Mine Drainages
(Water pollution control research series)
Shearer, Robert E. ; Everson, William A.
MSA Research Corp., Evans City, Pa.
Corp. Source Codes: 401623
Report No.: FWPCA-DAST-21; FWPCA-14010-EGJ-11/69; W70-05959
Nov 69 149p
NTIS Prices: PC A07 MF A01 Journal Announcement: USGRDR7013

The active agents in natural waters previously found to inhibit bacterial production of acid in streams were investigated in the laboratory, and inoculations of natural water previously found to be inhibitory were made, about 14,000 gallons each, to a worked-out mine in Pennsylvania. After the first inoculation, tests showed absence of inhibitory power in the water at the time it was collected, and the water used for the second test was similarly found to be only weakly inhibitory. Strains of Caulobacter were found in the natural inhibitory waters, and when adapted to acidic environments and concentrated in culture media, they induced inhibition of acid production. Other adapted strains of Caulobacters also induced inhibition. Some evidence was shown that Caulobacter inhibitors might move downstream. Four species of Streptomyces tolerated acidic conditions, and were effective against the acid-producing bacteria in test tube cultures and on solid media. (WRSIC abstract)

254

100

166066 PB-189 233
Oxygenation of Ferrous Iron: The Rate-Determining Step in the Formation of Acidic Mine Drainage
(Final progress rept. 1 Apr 66-31 Dec 68)
Singer, Philip C. ; Strumm, Werner
Harvard Univ., Cambridge, Mass.
Corp. Source Codes: 163700
Report No.: FWPCA-DAST-28; FWPCA-14010-06/69; W70-03434
Dec 68 216p
Document Type: Thesis
NTIS Prices: PC A10 MF A01 Journal Announcement: USGRDR7007
Contract No.: PH-36-66-107

The rate of oxidation of iron(II) by oxygen conforms to a relationship which is first-order in the concentrations of ferrous iron and oxygen, and second-order in the concentration of hydroxide ion, at pH values between 5.0 and 7.5. The reaction proceeds relatively rapid at pH values greater than 6.5; the half-time of the reaction is 4 minutes at pH 7.0, under a partial pressure of oxygen of 0.20 atmospheres at 25 deg C. The dependence of the oxidation rate on hydroxide concentration has been observed, in this study, at pH values as low as 4.5, where the half-time has increased to approximately 300 days. At lower pH values, the dependence of the reaction rate on pH becomes less marked until at pH values below 3.5, the oxidation proceeds at a rate which is independent of pH. Field results suggest that the observed rapidity of the reaction in acidic mine waters is apparently the result of microbial catalysis. The rate-limiting step among the reactions involved in the oxidation of iron pyrite and the production of acidity in mine drainage waters is the oxygenation of ferrous iron. Oxidation of iron pyrite is by a cyclical reaction involving the slow oxygenation of iron(II) to iron(III) followed immediately by the rapid reduction of iron(III) by pyrite, generating in turn more iron(II) and acidity. (WRSIC-abstract)

164245 PB-188 906
Algae in Relation to Mine Water
Bennett, Harald D.
West Virginia Univ., Morgantown. Water Research Inst.
Report No.: JOURNAL-1; OWRR-A-007-WVA(1); W70-02770
1969 25p
Pub as West Virginia Univ. Bull. Ser. 70, no. 6-2, Dec 69. Pub in Castanea, n34, p306-328, 1969.
NTIS Prices: PC A02 MF A01 Journal Announcement: USGRDR7006
Contract No.: DI-14-01-0001-707; DI-14-01-0001-819; OWRR-A-007-WVA

An annual cycle of bimonthly sampling was done to obtain information on species of algae tolerant to acid mine water and on chemical factors related to ecology of algae. Correlation was lacking between factors except acidity, iron, and pH. A range for these characterized each habitat, and they appeared controlling on algal population in more-acid streams. The total number of genera and species compared favorably with numbers reported from 'unpolluted' waters. Nearly half the total species found in more-acid streams equally were in less-acid creeks, rivers, and ponds. Algae characteristic mine water were those common to the other habitats. Reduction in numbers of species at higher acidity and lower pH was primarily in species less common to a range of habitats. The range of acidity and pH at a site is characterized by a range in species number and abundance--a change in abundance being dependent on the species. (Author)

162527 PB-188 945
Mine Water Research: Catalytic Oxidation of Ferrous Iron in Acid Mine Water by Activated Carbon
(Report of investigations)
Mihok, Edward A.
Bureau of Mines, Washington, D.C.
Corp. Source Codes: 068450
Report No.: RI-7337
Dec 69 11p
NTIS Prices: PC A02 MF A01 Journal Announcement: USGRDR7005

Laboratory batch-flow tests conducted on a highly ferruginous acid mine water with an activated carbon showed that ferrous iron is rapidly oxidized. This indicates that air oxidation of ferruginous acid in mine waters is catalyzed by activated carbon. The ferrous iron content of an acid mine water flowing through an aspirated activated carbon column was reduced from about 700 to about 10 parts per million in less than 1 minute. Highly efficient ferrous iron oxidation was achieved by conditioning the activated carbon by repeated treatment with acid mine water and air. The reaction proceeds rapidly in the acid environment (pH about 2.5) engendered by ferrous iron oxidation. The activated carbon was used repeatedly with little loss in efficiency, no discoloration, or solids deposition. In these batch tests, about one-third of the iron was adsorbed by the carbon, but with continuous flow, little iron adsorption is expected. Incorporating a catalytic oxidation step in the treatment of acid mine waters containing ferrous iron would greatly facilitate neutralization--precise control of pH, lower reagent costs, elimination of aeration equipment, and smaller holding ponds. (Author)

158038 PB-187 866
Sulfide Treatment of Acid Mine Drainage
(Water pollution control research series)
Bituminous Coal Research, Inc., Monroeville, Pa.
Report No.: W70-01488; DAST-2
Nov 69 73p
NTIS Prices: PC A04 MF A01 Journal Announcement: USGRDR7002
Contract No.: FWPCA-14010-DLC

During an earlier program a process for the treatment of coal mine drainage was conceived, involving the combined addition of limestone and hydrogen sulfide to effect precipitation of iron sulfides (LHS process). The black sludge formed during treatment undergoes oxidation at a rate depending on drying conditions with formation of elemental sulfur. X-ray diffraction analyses indicate the iron sulfide sludge component is an amorphous material. The unstable nature of the sulfide sludge, possibility of polysulfide formation during treatment, instability of mine waters of the type amenable to treatment, and inadequacies of available gas metering equipment are among the factors which militate against the controlled regulation of hydrogen sulfide feed necessary for successful operation of the process. These factors, and additional disadvantages revealed by an updated cost evaluation, lead to the conclusion that the LHS process is less attractive than accepted methods of mine drainage treatment. (Author)

C

APPENDIX C

NATIONAL TECHNICAL INFORMATION SERVICE (NTIS) DATABASE

SEARCH #3 OF 4

SEARCH STRATEGY:

[ACID MINE DRAINAGE OR MINE ACID DRAINAGE OR MINE WASTE(S) OR MINE WATER(S)]

AND

[PYRIT? OR SULPHIDE OR SULFIDE OR IRON OR TAILINGS]

AND

[BACTERIA? OR THIOBACIL? OR OXIDIZING OR OXIDATION]

NOT

[SEARCH #1 OR 2]

1022478 PB84-111814
'Candida albicans' as an Alternative Sanitary-Indicator Organism for Waters Containing Acid Mine Drainage
De Pasquale, D. A. ; Law, C. B. ; Bissonnette, G. K.
West Virginia Univ., Morgantown. Water Research Inst.
Corp. Source Codes: 015448063
Sponsor: Office of Water Research and Technology, Washington, DC.
Report No.: W84-00041; OWRT-A-047-WV(1)
1983 34p
Languages: English
NTIS Prices: PC A03/MF A01 Journal Announcement: GRAI8402
Country of Publication: United States
Contract No.: DI-14-34-0001-2152; OWRT-A-047-WV

Microbiological studies were conducted to assess the potential of using Candida albicans as a sanitary-indicator organism in streams impacted by acid mine drainage (AMD) and organic wastes. C. albicans was detected at low densities in AMD, particularly when compared to the occurrence of traditional indicator bacteria. The relatively lower density of C. albicans in AMD was a reflection of its likewise low incidence in raw sewage. Pure-culture survival studies indicated that C. albicans is extremely resistant to the adverse effects of AMD as demonstrated by prolonged persistence of at least three days. In addition to its extended survival, C. albicans incurred minimal sublethal injury from AMD stress.

1006393 NTN83-0303
Control of Acid Mine Drainage Using Surfactants
(NTIS Tech Note)
Department of the Interior, Washington, DC.
Corp. Source Codes: 004199000
May 83 1p
Write NTIS for information about Tech Notes subscriptions and back issue packages available.
Languages: English
NTIS Prices: Not available individually Journal Announcement: GRAI8324
Country of Publication: United States

This citation summarizes a one-page announcement of technology available for utilization. A method was developed to reduce acid mine drainage from coal refuse piles and surface mines by inhibiting the growth of acid-causing bacteria. A dilute surfactant or detergent solution is applied directly to coal refuse piles or overburden using a hydroseeder or road watering truck. The surfactant treatment can be used either as a preventive measure to avoid a potential acid drainage at its source. Acid drainage is prevented or reduced by inhibiting the growth of Thiobacillus ferrooxidans. The surfactant breaks down the bacteria's protective membrane which enables it to survive in acid environments. ...FOR ADDITIONAL INFORMATION: Contact: Robert L.P. Kleinmann, Bureau of Mines Pittsburgh Research Center, P.O. Box 18070, Pittsburgh, PA 15236; (412) 675-6555.

1000625 PB83-233387
Investigation of the Mechanics of Mine Acid Formation in Underground Coal Mine Drainage
(Open file rept. May 78-Jul 82)
Walsh, Fraser M.
ECO, Inc., Cambridge, MA.
Corp. Source Codes: 072517000
Sponsor: Bureau of Mines, Washington, DC.
Report No.: BUMINES-OFR-128-83
Jul 82 69p
See also PB81-179418.
Languages: English
NTIS Prices: PC A04/MF A01 Journal Announcement: GRAI8322
Country of Publication: United States
Contract No.: J0387215

The objective of this program was to determine by laboratory experiments the kinetics and mechanics of the reactions that produce acid in coal mine drainage. The program was divided into three phases: In Phase I, five coal mines, representative of Appalachian coal mines, were chosen for sampling and an experimental design was identified suited to accomplish the program objectives. In Phase II, the five mines were sampled and test protocols applied. The results showed most pyrite weathering to be based on oxidation in the presence of water. Iron bacteria, especially Thiobacillus ferrooxidans, catalyzed the rate of pyrite weathering by a factor of three. An increase in initial iron concentration in a system that modeled the mine environment acted to inhibit bacterial catalysis of weathering. In Phase III, five tailings piles were sampled and the material obtained was used to evaluate this method of bacterial catalysis inhibition. The evaluation verified method effectiveness; inhibition of over 80% of the release of weathering products was observed.

0996844 NTN83-0303

Control of Acid Mine Drainage Using Surfactants
(NTIS Tech Note)
Department of the Interior, Washington, DC.
Corp. Source Codes: 004199000
May 83 1p
Write NTIS for information about Tech Notes subscriptions and back issue packages available.
Languages: English
NTIS Prices: Not available individually Journal Announcement: GRAI8320
Country of Publication: United States

This citation summarizes a one-page announcement of technology available for utilization. A method was developed to reduce acid mine drainage from coal refuse piles and surface mines by inhibiting the growth of acid-causing bacteria. A dilute surfactant or detergent solution is applied directly to coal refuse piles or overburden using a hydroseeder or road watering truck. The surfactant treatment can be used either as a preventive measure to avoid a potential acid drainage at its source. Acid drainage is prevented or reduced by inhibiting the growth of Thiobacillus ferooxidans. The surfactant breaks down the bacteria's protective membrane which enables it to survive in acid environments. ...FOR ADDITIONAL INFORMATION: Contact: Robert L.P. Kleinmann, Bureau of Mines Pittsburgh Research Center, P.O. Box 18070, Pittsburgh, PA 15236; (412) 675-6555.

0983731 DE83007965

Subsurface Oxidation of Pyritic Coal-Cleaning Wastes by Chemoautotrophic Bacteria
Schubert, J. P. ; Miller, R. M.
Argonne National Lab., IL.
Corp. Source Codes: 001960000; 0448000
Sponsor: Department of Energy, Washington, DC.
Report No.: CONF-821175-1
Nov 82 19p
Symposium on surface mining hydrology, sedimentology, and reclamation, Lexington, KY, USA, 1 Nov 1982, Portions are illegible in microfiche products.
Languages: English Document Type: Conference proceeding
NTIS Prices: PC A02/MF A01 Journal Announcement: GRAI8316 ; NSA0800
Country of Publication: United States
Contract No.: W-31-109-ENG-38

The presence of the iron-oxidizing bacterium Thiobacillus ferrooxidans was investigated in groundwater and surface water at two coal refuse disposal sites in southwestern Illinois. Piezometers placed in the saturated bases of reclaimed and unreclaimed refuse piles showed high populations of the bacteria. The reclaimed pile had lower populations than did the unreclaimed coal refuse, suggesting that the reclamation effort may have caused a decline in subsurface Thiobacillus population levels. Acidic runoff water from the two piles also contained T. ferrooxidans but the levels encountered are not as high as those found in the saturated bases. Population levels of T. ferrooxidans were not high in till below the gob pile or in slurry material at the Staunton site. This may be attributed to the lower acidity and dissolved iron concentrations in groundwater at these locations, as well as to the lack of pyrite in the till and slurry material. Statistical analysis of T. ferrooxidans populations and six water quality variables for runoff and groundwater samples from the two sites showed that all seven variables were significantly intercorrelated. More samples and additional variables must be evaluated before cause/effect relationships can be determined. High populations of T. ferrooxidans were found in the saturated bases of the two refuse piles, despite low levels (< 0.5 mg/L) of dissolved oxygen. If these bacteria can catalyze pyrite oxidation under the conditions present, reduction of acid formation by refuse burial may not be successful. (ERA citation 08:019595)

0977439 PB83-180273

Biogeochemistry of Arsenic Mine Drainage
Luong, Huan V. ; Forshaug, Joan M. ; Brown, Edward J.
Alaska Univ., Fairbanks. Inst. of Water Resources.
Corp. Source Codes: 001217010
Sponsor: Office of Water Research and Technology, Washington, DC.
Report No.: W83-02290; OWRT-B-045-ALAS(1)
Nov 81 20p
Languages: English
NTIS Prices: PC A02/MF A01 Journal Announcement: GRAI8314
Country of Publication: United States
Contract No.: DI-14-34-0001-0202; OWRT-B-045-ALAS

Arsenic is enriched in gold and sulfide deposits throughout many areas of Alaska. Consequently, some stream waters, stream sediments and groundwaters contain dissolved arsenic concentrations in excess of the Environmental Protection Agency's recommended limit of 50 parts per billion (ppb: Wilson and Hawkins, 1978). We report here that the acidiophile, T. ferrooxidans is present in most neutral pH subarctic streams affected by gold mining activities. Some of these streams have measurable levels of dissolved arsenic while others do not. We also report that the presence of T. ferrooxidans increases the rate that arsenic leaches from gold-bearing material at least fourfold over the abiotic leaching rate. Whatever the mechanism of heavy metal leaching in the areas described, mining activity continues to increase. The authors feel, therefore, that studies of the biogeochemistry of these areas should continue.

952930 PB83-140616
Acid Mine Drainage: Control and Abatement Research
(Information circular/1982)
Kim, Ann G. ; Heisey, Bernice S. ; Kleinmann, Robert L. P. ; Deul, Maurice
Bureau of Mines, Pittsburgh, PA. Pittsburgh Research Center.
Corp. Source Codes: 004993027
Report No.: BUMINES-IC-8905
Oct 82 27p
Library of Congress catalog card no. 82-19724.
Languages: English
NTIS Prices: PC A03/MF A01 Journal Announcement: GRAI8307
Country of Publication: United States

Acid drainage from underground coal mines and coal refuse piles is one of the most persistent industrial pollution problems in the United States. This Bureau of Mines report reviews the acid mine drainage problem generally and describes research currently underway to combat it.

943136 DE82019485
Leaching Behaviors of High-Sulfur Coal Wastes from Two Appalachian Coal-Preparation Plants
Heaton, R. C. ; Williams, J. M. ; Bertino, J. P. ; Wangen, L. E. ; Nyitray, A. M.
Los Alamos National Lab., NM.
Corp. Source Codes: 072735000; 9512470
Sponsor: Department of Energy, Washington, DC.
Report No.: LA-9356-MS
Jun 82 81p
Microfiche only after original copies are exhausted.
Languages: English
NTIS Prices: PC A05/MF A01 Journal Announcement: GRAI8303 ; NSA0700
Country of Publication: United States
Contract No.: W-7405-ENG-36

We have completed an assessment of the environmental behaviors of high-sulfur coal wastes obtained from two coal preparation plants located in northern Appalachia. Leachates obtained from these materials are often very acidic, with pH values sometimes less than 2, and contain high concentrations of a number of chemical elements. Aluminum, manganese, iron, nickel, and sometimes copper, zinc, and cadmium are released in environmentally harmful concentrations according to the Environmental Protection Agency Multimedia Environmental Goals/Minimum Acute Toxicity Effluent (MEG/MATE) system of evaluation. Iron is the worst case, with concentrations typically more than 20 times the acceptable level. In terms of leaching behavior, these wastes are very similar to the Illinois Basin coal wastes that we have studied in the past. Unless properly disposed of, these wastes may cause serious environmental degradation as a result of contaminated drainages. Studies of the chemical composition and morphology of these coal wastes reveal that many of the environmentally important elements leached from the solid wastes in high percentages (Fe, Co, Ni, Cu, Zn, As, Se) tend to reside among either mixed-layer clays or pyritic mineral phases. Elements associated with quartz or more orderly clays, such as kaolinite or illite, are generally leached in lower percentages. Important determinants of coal waste leaching behavior are pyrite, which determines the acid generating potential of the waste, calcite, which determines the capacity of the waste to self-neutralize the acids released by oxidation of pyrite, and the clay minerals, which serve as reservoirs for many of the leachable trace elements. (ERA citation 07:052596)

915921 PB82-810680
Bacterial Pollution of Water. March, 1979-July, 1982 (Citations from the NTIS Data Base)
National Technical Information Service, Springfield, VA.
Corp. Source Codes: 055665000
Jul 82 290p
Supersedes PB81-806895, and PB80-806086.
Languages: English Document Type: Bibliography
NTIS Prices: PC N01/MF N01 Journal Announcement: GRAI8223
Country of Publication: United States

These selected abstracts of research reports cover bacteria, especially coliform bacteria, found polluting natural bodies of water, mine water, sewage effluents, and water used in food processing. (This bibliography contains 281 citations, 87 of which are new entries to the previous edition.)

881571 DE81027531

Environmental Control Technology Survey of Selected US Strip Mining Sites. Volume 3. Control Technology

Bogner, J. E. ; Schubert, J. P. ; Kaszynski, G. M.
Argonne National Lab., IL.
Corp. Source Codes: 001960000; 0448000
Sponsor: Department of Energy, Washington, DC.
Report No.: ANL/EMR-2VOL.3
Feb 81 280p
Languages: English
NTIS Prices: PC A13/MF A01 Journal Announcement: GRAI8205 ; NSA0900
Country of Publication: United States
Contract No.: W-31-109-ENG-38

The environmental control technology for maintaining water quality at 21 surface mines in eastern and central US coalfields is summarized. The mines ranged from small contour-mining operations to large area mines. Seven mines used chemical reagents to neutralize acid effluents in order to conform to federal regulations. The remaining 14 mines used only settling ponds, in an effort to reduce concentrations of suspended solids. Because effluent discharges at surface coal mines do not remain in the same places over long periods of time, and because discharges are generally small (<5 gal/min) and variable, surface mine operators favor small, efficient, portable systems for applying neutralization reagents. Reagent cost is less important to surface coal mine operators than is the labor cost required for reagent application and handling. Thus, small caustic soda and soda ash treatment systems are common, even though the cost of these reagents (based on treating water of equivalent acidity) may be several times that of hydrated lime or limestone treatment. Water chemistry data indicated that the mines achieved varying degrees of success with their control technology. Costs of water treatment are expected to rise in response to enforcement of the final federal regulations for coal mine effluents; these increases will be greater in the Appalachian region than in the central United States. Surface mine operators should concentrate on pre-mining planning in order to minimize pyrite oxidation and resulting acid mine drainage. Preventing generation of poor-quality effluents, rather than maintaining treatment facilities during and after mining, could result in long-term cost savings. (ERA citation 06:029240)

881405 ANL/EMR-2(V.2A)

Environmental Control Technology Survey of Selected US Strip Mining Sites. Volume 2A: Ohio: Water Quality Impacts and Overburden Chemistry of Ohio Study Site

Bogner, J. E. ; Henricks, J. D. ; Olsen, R. D. ; Schubert, J. P. ; Sobek, A. A.
Argonne National Lab., IL.
Corp. Source Codes: 001960000; 0448000
Sponsor: Department of Energy, Washington, DC.
May 79 146p
Languages: English
NTIS Prices: PC A07/MF A01 Journal Announcement: GRAI8205 ; NSA0500
Country of Publication: United States
Contract No.: W-31-109-ENG-38

An intensive study of water, overburden, and coal chemistry was conducted at a large surface mine in Ohio from May 1976 through July 1977. Sampling sites were chosen to include the final mine effluent at the outflow of a large settling pond and chemically-treated drainage from a coal storage pile. Samples were collected semimonthly and analyzed for total dissolved solids, total suspended solids, alkalinity, acidity, sulfate, chloride, and 16 metals. Field measurements included pH, flow rate, dissolved oxygen, and specific conductance. The final effluent, where sampled, generally complied with Office of Surface Mining reclamation standards for pH, iron, and total suspended solids. Comparison of the final effluent with water quality of an unnamed tributary above the mine suggested that elevated values for specific conductance, total dissolved solids, sulfate, calcium, magnesium, manganese, and zinc were attributable to the mine operation. In general, there were observable seasonal variations in flow rates that correlated positively to suspended solids concentrations and negatively to concentrations of dissolved constituents in the final effluent. Drainage from the coal storage pile contained elevated levels of acidity and dissolved metals which were not reduced significantly by the soda ash treatment. The storage pile drainage was diluted, however, by large volumes of alkaline water in the settling pond. Analysis of overburden and coal indicated that the major impact of mine drainage was pyrite oxidation and hydrolysis in the Middle Kittanning Coal and in the Lower Freeport Shale overlying the coal. However, the presence of a calcite-cemented section in the Upper Freeport Sandstone contributed substantial self-neutralizing capacity to the overburden section, resulting in generally alkaline drainage at this site. (ERA citation 05:019549)

856725 PB81-806895
Bacterial Pollution of Water. March, 1979-June, 1981 (Citations from the NTIS Data Base)
(Rept. for Mar 79-Jun 81)
National Technical Information Service, Springfield, VA.
Corp. Source Codes: 055665000
Jun 81 201p
Supersedes PB80-806086, and NTIS/PS-79/0216. See also 1964-February, 1976, NTIS/PS-77/0017, and March, 1976-February, 1979, PB80-806078.
Languages: English Document Type: Bibliography
NTIS Prices: PC N01/MF N01 Journal Announcement: GRAI8121
Country of Publication: United States

These selected abstracts of research reports cover bacteria, especially coliform bacteria, found polluting natural bodies of water, mine water, sewage effluents, and water used in food processing. (This bibliography contains 194 citationr, 131 of which are new entries to the previous edition.)

843017 PB81-179418
Investigation of the Mechanics of Mine Acid Formation in Underground Coal Mine Drainage
(Open file rept. (Interim) May 78-Dec 79)
Walsh, Fraser
ECO, Inc., Cambridge, MA.
Corp. Source Codes: 072517000
Sponsor: Bureau of Mines, Washington, DC.
Report No.: BUMINES-OFR-22-81
Nov 80 122p
Languages: English
NTIS Prices: PC A06/MF A01 Journal Announcement: GRAI8116
Country of Publication: United States
Contract No.: J0387215

This study investigates the kinetics and the mechanics of the reactions that produce acid in coal mine drainage using fresh mine face samples from five Appalachian coal mines. The results of the study show that pyrite weathering is based on oxidation in the presence of water where the oxidants can be either ferric iron or oxygen. Iron bacteria, especially T. ferrooxidans, catalyze the rate of pyrite weathering by a factor of 3. An increase in initial iron concentration in a system that models the mine environment acts to inhibit bacterial catalysis of pyrite weathering.

833920 PB81-157075
Indicator-Organism Persistence in Acid-Mine-Water Environments
(Technical completion rept.)
Carlson, Nancy E. ; Bissonnettes, Gary K.
West Virginia Univ., Morgantown. Water Research Inst.
Corp. Source Codes: 015448063
Sponsor: Office of Water Research and Technology.
Jan 81 48p
Languages: English
NTIS Prices: PC A03/MF A01 Journal Announcement: GRAI8113
Country of Publication: United States
Contract No.: DI-14-34-0001-0152; OWRT-A-309-WVA

Persistence of indicator organisms (total coliforms, fecal coliforms, and fecal streptococci) associated with natural samples of raw, primary- and secondary-treated sewage was studied following in-situ exposure to five aquatic environments. Three of these streams contained significant amounts of acid mine drainage. The other two streams were relatively uncontaminated. Indicator organisms were rapidly killed upon exposure to the acid-mine systems. In most cases, the survivors were reduced more than 90 percent within 30 minutes. Little reduction in numbers was observed in the uncontaminated streams. Seasonal changes affected survival of indicators as reflected by slightly prolonged persistence at colder in-situ water temperatures. The fecal coliform group was most susceptible to the acid-mine-water stress. The fecal streptococci were the most persistent. An enrichment technique resulted in substantially enhanced recovery of sublethally-injured survivors of acid stress. Enrichment was particularly beneficial for recovery of acid-injured fecal coliforms. Relatively little improvement in recovery of fecal streptococci was afforded by the enrichment technique.

800371 FE-8977-T1
Investigation of Mechanics of Mine Acid Formation. Volume 1
Paciorek, K. L. ; Kimble, P. F. ; Vatasescu, A. L. ; Toben, W. A. ; Kratzer, R. H.
Ultrasystems, Inc., Irvine, CA.
Corp. Source Codes: 9502601
Sponsor: Department of Energy, Washington, DC.
Mar 80 142p
Languages: English
NTIS Prices: PC A07/MF A01 Journal Announcement: GRAI8026 ; NSA0500
Country of Publication: United States
Contract No.: ET-78-C-01-8977

The objective of the contract was to determine, by the combination of laboratory experiments and mine samplings, the kinetics and mechanisms of the various reactions that produce mine acid drainage. To achieve this goal, primary investigations were performed utilizing pure iron disulfide in the form of pyrite and marcasite, free from coal. The effects of temperature, concentration, surface area, media nature, oxygen, presence of additional ions and bacterial action with respect to dissolution rates were measured. Thiobacillus ferrooxidans and T. thiooxidans were included in this study, both as purchased cultures and freshly isolated from mine samples. Mine samplings were performed to determine the type and quantity of bacteria present, the effect of weathering upon coals' propensity to produce acid and other drainage, the effect of other minerals and the nature of the mine water upon ion liberation, and the effect of the different kinds of bacteria upon the above process. It was established that both pyrite and marcasite, provided sufficient surface area is exposed, will produce hydrogen, sulfate, and iron ions. This process is accelerated in the case of pyrite and marcasite by the presence of T. ferrooxidans and ferric ions. T. thiooxidans accelerates marcasite solubilization and the dissolution of iron disulfide present in coal, but had no effect on museum grade pyrite. (ERA citation 05:030142)

771925 PB80-176357
Evaluation of Chemical Agents for Inhibiting Acid Mine Drainage Formation
(Final rept.)
Nebgen, John W. ; Weatherman, Douglas F.
Midwest Research Inst., Kansas City, MO.
Corp. Source Codes: 018262000
Sponsor: Bureau of Mines, Washington, DC.
Report No.: BUMINES-OFR-49-80
Apr 79 128p
Languages: English
NTIS Prices: PC A07/MF A01 Journal Announcement: GRAI8016
Country of Publication: United States
Contract No.: J0366036

This report contains findings from a Bureau of Mines study concerning the inhibition of acid mine drainage formation from underground coal mines. A series of experiments was performed in which three different pyritic materials (wastes from coal production plants) were evaluated using several candidate inhibiting agents. Data obtained from the inhibitor-treated pyrites were compared with data from control experiments in which untreated pyritic wastes were used. The experiments were conducted by placing treated and untreated pyrite in columns, passing moist air through the columns to promote oxidation of pyrite, and washing the columns weekly to collect oxidation products for analysis. The results indicate that quantities of acid mine drainage can be substantially reduced if soluble iron III (ferric) ion is controlled.

761078 CONF-7905124-1
Distribution of Selected Transition and Heavy Metals in Clastic Overburden Units of the Appalachian and Interior Coal Basins: Water Quality Implications
Bogner, J. E. ; Sobek, A. A.
Argonne National Lab., IL.
Corp. Source Codes: 001960000; 0448000
Sponsor: Department of Energy.
1979 36p
International congress of carboniferous stratigraphy and geology, Urbana, IL, USA, 19 May 1979.
Languages: English Document Type: Conference proceeding
NTIS Prices: PC A03/MF A01 Journal Announcement: GRAI8013 ; NSA0500
Country of Publication: United States
Contract No.: W-31-109-ENG-38

As part of a study to investigate possible sources of transition and heavy metals transported in coal mine drainage, overburden lithologies from 18 surface mines in the Appalachian and Interior Basins were sampled and analyzed for total chemistry. The mines were widely scattered geographically so that samples could be obtained of as many representative lithologies as possible. Overburden units were predominantly Pennsylvanian basin margin clastics, with some Pennsylvanian carbonates and Pleistocene sediments in the Interior Basin. Based on lithologic descriptions, relative percentages of silicon and aluminum, and gross mineralogy from semiquantitative x-ray diffraction, the average metals concentrations for overburden units were developed for two major lithologic groups: (1) quartz-rich units, including sandstones, siltstones, and silts; and (2) clay-rich units, including shales, claystones, clays and tills. Comparing the regional averages for this study with published averages for the coals of the two regions, the highest average concentrations of most metals occurred in the fine-grained (clay-rich) units of the two regions; exceptions were chromium, strontium, and lead in Interior Basin quartz-rich units; and zinc and sulfur in Interior Basin coals. Manganese concentrations were elevated in the quartz-rich units of both regions. In general, the Interior Basin quartz-rich units and coals contained high average concentrations of iron and sulfur; however, substantial quantities of neutralizers (reflected in high average calcium content and high neutralization potential) were also present in the Interior Basin clastics. (ERA citation 05:006325)

758189 PB80-806086
Bacterial Pollution of Water. Volume 3. March, 1979-February, 1980 (Citations from the NTIS Data Base)
(Rept. for Mar 79-Feb 80)
Harrison, Elizabeth A.
National Technical Information Service, Springfield, VA.
Corp. Source Codes: 055665000
Mar 80 70p
Supersedes NTIS/PS-79/0216, NTIS/PS-78/0113, and NTIS/PS-77/0118. See also Volume 1, 1964-February, 1976, NTIS/PS-77/0017, and Volume 2, March, 1976-February, 1979, PB80-806078.
Languages: English Document Type: Bibliography
NTIS Prices: PC N01/MF N01 Journal Announcement: GRAI8011
Country of Publication: United States

These selected abstracts of research reports cover bacteria, especially coliform bacteria, found polluting natural bodies of water, mine water, sewage effluents, and water used in food processing. (This bibliography contains 63 abstracts, all of which are new entries to the previous edition.)

758188 PB80-806078
Bacterial Pollution of Water. Volume 2. March, 1976-February, 1979 (Citations from the NTIS Data Base)
(Rept. for Mar 76-Feb 79)
Harrison, Elizabeth A.
National Technical Information Service, Springfield, VA.
Corp. Source Codes: 055665000
Mar 80 245p
See also Volume 1, 1964-February, 1976, NTIS/PS-77/0117.
Languages: English Document Type: Bibliography
NTIS Prices: PC N01/MF N01 Journal Announcement: GRAI8011
Country of Publication: United States

These selected abstracts of research reports cover bacteria, especially coliform bacteria, found polluting natural bodies of water, mine water, sewage effluents, and water used in food processing. (This updated bibliography contains 238 abstracts, none of which are new entries to the previous edition.)

797740 PB80-144793
Environmental Effects of Western Coal Surface Mining. Part IV--Chemical and Microbiological Investigations of a Surface Coal Mine Settling Pond
(Final rept.)
Turbak, Susan C. ; Olson, Gregory J. ; McFeters, Gordon A.
Colorado State Univ., Fort Collins. Natural Resource Ecology Lab.
Corp. Source Codes: 006665084
Sponsor: Environmental Research Lab.-Duluth, MN.
Report No.: EPA-600/3-79-126
Dec 79 82p
See also report dated Oct 78, PB-289 883. Prepared in cooperation with Montana State Univ., Bozeman. Dept. of Microbiology.
Languages: English
NTIS Prices: PC A05/MF A01 Journal Announcement: GRAI8011
Country of Publication: United States
Contract No.: EPA-R-803950

Chemical and microbiological investigations of the settling pond system at the West Decker Coal Mine in southeastern Montana were undertaken during 1975-1977. Concentrations of total dissolved solids, bicarbonate, sodium, sulfate, and nitrogen species in pond water were elevated in comparison to those in other nearby surface waters; however, it was concluded that these would not significantly impact the nearby Tongue River or Tongue River Reservoir. Constituents of the mine drainage waters underwent chemical changes within the pond which were at least in part due to the activities of microorganisms. The increase in pH value and in concentration of dissolved oxygen, partially attributed to photosynthesis within the pond, oxidized reduced chemical species such as sulfide and ferrous iron. The high numbers and activity measurements of sulfate reducing bacteria as well as the significant amount of metal-bound sulfides in pond sediments made a strong case for the contributions of these organisms to metal precipitation in, and possible detoxification of, pond waters.

699053 NTIS/PS-79/0216/6
Bacterial Pollution of Water. Volume 2. February, 1976-February, 1979 (A Bibliography with Abstracts)
(Rept. for Feb 1976-79)
Harrison, Elizabeth A.
National Technical Information Service, Springfield, VA.
Corp. Source Codes: 391612
Mar 79 244p
Supersedes NTIS/PS-78/0113, NTIS/PS-77/0118, NTIS/PS-76/012-0, and NTIS/PS-75/129. See also Volume 1, 1964-February, 1976, NTIS/PS-77/0117.
Languages: English Document Type: Bibliography
NTIS Prices: PC N01/MF N01 Journal Announcement: GRAI7911

These selected abstracts of research reports cover bacteria, especially coliform bacteria, found polluting natural bodies of water, mine water, sewage effluents, and water used in food processing. (This updated bibliography contains 238 abstracts, 42 of which are new entries to the previous edition.)

697155 PB-291 722/7
Microbial Sulfur Cycle Activity at a Western Coal Strip Mine
(Completion rept.)
Olson, Gregory J. ; McFeters, Gordon A.
Montana State Univ., Bozeman. Water Resources Research Center.
Sponsor: Office of Water Research and Technology, Washington, DC.
Report No.: MUJWRRC-98; W79-03308; OWRT-A-108-MONT(1)
Nov 78 90p
Languages: English
NTIS Prices: PC A05/MF A01 Journal Announcement: GRAI7910
Contract No.: DI-14-34-0001-8028; OWRT-A-108-MONT

Certain groups of sulfur cycle bacteria found in waters, sediments, and the coal seams of a strip mine at Decker and other mines of southeastern Montana and northeastern Wyoming were studied. Thiobacillus ferrooxidans, one of the major contributors to acid mine drainage, was consistently detected in the mining environment. Physiological studies of T. ferrooxidans isolates indicated that these acidophilic iron and sulfur oxidizing organisms were typical of the species in their preference for low pH and ability to oxidize pyrite. Hydrogen sulfide and sulfate reducing bacteria were detected in the water from all but one of the wells sampled in over a wide area in southeastern Montana. Although the activity of these organisms in the groundwater could not be demonstrated, a comparison of stable sulfur isotope ratios between groundwater sulfates and sulfides indicated the sulfide was likely produced by sulfate reducing bacteria.

694804 PB-291 369/7
Pollution Control Guidelines for Coal Refuse Piles and Slurry Ponds
(Final rept. Dec 75-Jul 77)
Wahler (W. A.) and Associates, Palo Alto, CA.
Sponsor: Industrial Environmental Research Lab.-Cincinnati, OH.
Report No.: EPA/600/7-78/222
Nov 78 228p
Languages: English
NTIS Prices: PC A11/MF A01 Journal Announcement: GRAI7909
Contract No.: EPA-68-03-2344; EPA-68-03-2431

A large percentage of the eastern coal mined today is washed and processed to remove impurities and increase quality. The wastes from the preparation process pose a serious disposal problem. The study investigated acid and heavy metal ion concentrations in water passing through refuse piles, suspended solids in waters from refuse areas and slurry ponds, noxious gases from oxidation and fires in refuse piles, and airborne particulates from dry exposed refuse surfaces.

690936 PB-289 487/1
Pollution Concentrations in Runoff Water from Refuse Piles
Guin, J. A.
Auburn Univ., AL. Water Resources Research Inst.
Sponsor: Office of Water Research and Technology, Washington, DC.
Report No.: WRRI-BULL-26; W79-01892; OWRT-B-026-ALA(3)
Mar 77 49p
Languages: English
NTIS Prices: PC A03/MF A01 Journal Announcement: GRAI7907
Contract No.: OWRT-B-056-ALA

In the processes of removal, refinement and disposal of raw materials, large quantities of waste products become exposed to weathering forces. Subsequent percolation, flushing, and oxidation results in the pollution of waterways, low-lying farmlands and underground aquifers with acidity, alkalinity, hardness, heavy metals, and undesirable organic materials such as tannin and lignin. The need for methodology for estimating the chemical nature and quantity of these leachates becomes more compelling as the extraction of natural materials accelerates. In this work a mass transfer model is formulated which describes the leaching of such pollutants from refuse piles. The model is applied to an actual refuse pile under natural precipitation and weathering conditions and found to adequately represent the pollutant concentrations in the rainfall runoff.

688900 PB-288 940/7
Geochemistry of Mine Effluents in the Front Range Mineral Belt of Colorado
(Master's thesis)
Rojas, Armando Jose Ramirez
Colorado School of Mines, Golden.
Corp. Source Codes: 088280
Sponsor: Office of Water Research and Technology, Washington, DC.
Report No.: T-1888; W79-01363; OWRT-A-034-COLO(1)
Dec 76 120p
Languages: English Document Type: Thesis
NTIS Prices: PC A06/MF A01 Journal Announcement: GRAI7906
Contract No.: DI-14-34-0001-7012; OWRT-A-034-COLO

Results of the chemical analyses of water draining from 7 mine adits within five mining districts were compared to the ore petrology, ore mineralogy, and type of ore deposit. The water samples were collected in the Front Range Mineral Belt of Colorado in which most of the metal deposits are predominantly a complex mixture of copper, lead, zinc, and silver sulfides, gold tellurides and arsenides. The oxidation of pyrite which is associated with these complex ores yields acid water containing high concentrations of iron, sulfate and other trace metals contained in its structure. This acidity promotes the dissolution and oxidation of the other sulfides which release high concentrations of base metals to the water, but no additional acidity. The position and movement of the water table related to the ore veins and the type of ore play an important role in determining changes in the water quality from metal mine drainages. From these results, it was found that all the mine effluents fit the diffuse aquifer system. The Emmett and Clyde Mines are a good example of the type of ore vs. the water quality. In the Emmett Mine the acidity generated from the oxidation of pyrite promotes the solubility of fluorite which releases hydrofluoric acid which attacks the silicate rocks. All these reactions are responsible for the chemistry of the water found in this adit. The Clyde Mine, which shows almost complete absence of sulfide minerals, has the best water quality of all the mine effluents studied. Calculated values for redox potentials using the ferric/ferrous couple and taking into account the ionic strength activity coefficients and ferric sulfate and fluoride complexes agree very well with the measured Eh values. Conductivity was also found to correlate really well with the total dissolved solids. These results demonstrate the utility of Eh and conductance measurements in acid mine drainages.

686410 PB-286 186/3
Recovery of Sanitary-Indicator Bacteria from Streams Containing Acid Mine Water
(Masters thesis)
Doubl, Mark L.
West Virginia Univ., Morgantown.
Corp. Source Codes: 374100
Sponsor: Office of Water Research and Technology, Washington, DC.
Report No.: W79-06444; OWRT-A-033-WVA(1)
1977 159p
See also report dated 1978, PB-285 962.
Languages: English Document Type: Thesis
NTIS Prices: PC A07/MF A01 Journal Announcement: GRAI7905
Contract No.: OWRT-A-033-WVA

Improved membrane-filtration methods for better recovery of sanitary-indicator organisms from aquatic environments containing acid mine water were evaluated. Adjustment of sample pH, use of various membrane-filter brands, and incorporation of an enrichment step were examined for samples from various aquatic environments. Comparison of the recovery efficiency of various methods used to enumerate coliform bacteria from water indicated that generally, multiple-tube fermentation techniques give recovery superior to membrane-filtration procedures, but use of resuscitation broth as an enrichment medium greatly improved the recovery efficiency of the membrane-filtration technique. In some instances, recovery densities of the enriched membrane-filtration method were greater than the Most-Probable-Number technique. Comparison of three brands of membrane filters revealed that Gelman GN-6 yielded the highest coliform recovery and Nuclepore the least. Other methods used to improve the membrane-filtration efficiency proved ineffective. Qualitative studies of the Hartman Run drainage area showed that acid mine water may produce a differential inhibitory effect to members of the Enterobacteriaceae. The use of a two-step enrichment procedure improved the recovery of certain genera, Klebsiella. That enrichment techniques be adapted to aid in assessing the sanitary quality of water is recommended.

678869 PB-285 962/7
Recovery of Sanitary-Indicator Bacteria from Streams Containing Acid Mine Water
Double, Mark L. ; Savio, John A. ; Bissonnette, Gary K.
West Virginia Univ., Morgantown. Water Research Inst.
Sponsor: Office of Water Research and Technology, Washington, DC.
Report No.: INFORMATION-11; WRI-WVU-78-02; W78-11217; OWRT-A-033-WVA(2)
1978 37p
Languages: English
NTIS Prices: PC A03/MF A01 Journal Announcement: GRAI7901
Contract No.: DI-14-34-0001-8061; OWRT-A-033-WVA

Quantitative and qualitative bacteriological studies were conducted on several streams simultaneously affected by acid-mine water and organic-waste pollution. Conventional direct membrane filtration techniques were found to be inadequate to recover sublethally injured coliforms from such aquatic environments when compared to recovery obtained by multiple-tube fermentation techniques. Substantially enhanced recovery of sublethally injured coliforms resulted upon the inclusion of an enrichment step when using the membrane filtration procedure. Qualitatively, several members of the Enterobacteriaceae were identified, including Escherichia coli, Enterobacter aerogenes, Enterobacter cloacae, Citrobacter freundii, Citrobacter intermedius, Klebsiella ozaenae, and Klebsiella pneumoniae. Differential qualitative distribution of the coliform species as a function of sampling location revealed some changes in population make-up, suggesting a differential inhibitory effect of acid-mine water on the respective members of the Enterobacteriaceae. Quantitative detection of fecal streptococci from the streams affected by acid-mine water was accomplished with relative ease, indicating that consideration should be given to employing this group as reliable indicators of bacteriological quality of aquatic environments affected by acid-mine drainage. Qualitatively, all members of the fecal streptococcal group were isolated from the streams affected by acid-mine water, with the exception of Streptococcus bovis and Streptococcus equinis. 'Total' plate counts, performed on several water samples during the summer months, reflected negligible differences in quantitative detection of bacteria as a function of three different incubation temperatures (10, 20, and 35C).

679311 LA-7630
Trace Element Characterization of Coal Wastes. Second Annual Progress Report, October 1, 1976--September 30, 1977
Wewerka, E. M. ; Williams, J. M. ; Vanderborgh, N. E. ; Harmon, A. W. ; Wagner, P.
Los Alamos Scientific Lab., NM.
Corp. Source Codes: 3820000
Sponsor: Department of Energy.
Report No.: EPA-600/7-78-028A
Jul 78 164p
Languages: English
NTIS Prices: PC A08/MF A01 Journal Announcement: GRAI7901 ; NSA0300
Contract No.: W-7405-ENG-36

Analyses of the trace elements and major minerals in bulk refuse and coal samples from the Illinois Basin were completed. This activity was followed by studies to elucidate the structural relationships and associations among the trace elements. Several series of weathering and leaching experiments were conducted to define the environmental behavior of the trace elements in the refuse and coal samples under various environmental conditions. These investigations resulted in the identification of the trace elements of most environmental concern in typical Illinois Basin refuse and coal. Methods to control the trace element contamination of refuse and coal drainage are being investigated. These refuse materials are very complex. Some 55 elements have been identified in most of the refuse samples and undoubtedly there are more. The most abundant of these elements, iron, aluminum, and silicon, compose the structures of the major mineral systems. A large number of elements generally considered to be environmentally sensitive are present in these refuse materials in significant quantities (>30 mu g/g). Included among these are fluorine, aluminum, manganese, iron, cobalt, nickel, copper, zinc, arsenic, and lead. Although the relative amounts of some of these components are seemingly small, the absolute quantities available in a large or active waste dump could cause grave consequences in the surrounding environment if they were to be released and concentrated by natural processes. (ERA citation 03:051767)

678863 IS-ICP-57
Environmental Control Technology Survey: Iowa Coal Project Demonstration Mine No. 1
Gulliford, J. B. ; Sendlein, L. V. A.
Iowa State Univ. of Science and Technology, Ames. Energy and Mineral Resources Research Inst.
Corp. Source Codes: 9501383
31 Jan 78 71p
NTIS Prices: PC A04/MF A01 Journal Announcement: GRAI7825 ; NSA0300

As a result of the Iowa Coal Project Demonstration Mine No. 1, 108,000 tons of coal resources were recovered and the land surface was transferred from a steeply sloped pasture to a benched terraced topography capable of supporting intensive agriculture. The permanent environmental impact of the site is improved because water runoff from the site is controlled by the installation of lesser slopes. Measures could be taken, however, to lessen the environmental impact during mining. Better sediment control structures could be developed. A connected, two-pond system would allow for sediment control in the upper pond, treatment accessability between ponds, and a lower pond to allow the flocculents caused by treatment to settle out before the water is released to the receiving stream. During mining the primary source of acid drainage to the sediment pond was the large stock pile of toxic shales. Were the size of this operation larger, the exposure of this pile to weathering would have been longer. Future mining plans might include covering the acid shale pile with non-toxic materials to prevent oxidation and the generation of acid mine drainage. This of course would be dependent upon the size of the pile, the cost, availability of non-toxic materials and the requirement that the stockpile size not change over time. Covering and revegetating the acid shale pile would reduce the acid source and perhaps reduce the costs of acid neutralization at the pond. (ERA citation 03:046374)

672661 PB-284 067/8
An Evaluation of Problems Arising from Acid Mine Drainage in the Vicinity of Shasta Lake, Shasta County California
(Final rept.)
Fuller, Richard H. ; Shay, Johneven H. ; Ferreira, Rodger F. ; Hoffman, Ray J.
Geological Survey, Menlo Park, Calif. Water Resources Div.
Corp. Source Codes: 409163
Sponsor: California Regional Water Quality Board, Sacramento. Central Valley Region.
Report No.: USGS/WRD/WRI-78/066; USGS/WRI-78-32
May 78 44p
Prepared in cooperation with California Regional Water Quality Control Board, Sacramento. Central Valley Region.
NTIS Prices: PC A03/MF A01 Journal Announcement: GRAI7824

Streams draining the mined areas of massive sulfide ore deposits in the East and West Shasta Mining Districts of northern California are generally acid and contain large concentrations of dissolved metals, including iron, copper, and zinc. The streams, including Flat, Little Backbone, Spring, West Squaw, Horse, and Town Creeks, discharge into Shasta Lake and the Sacramento River and have caused numerous fish kills. The major source of pollution is discharge from underground mines. A secondary source of pollution is streamflow and surface runoff that has passed through mine dumps where the oxidation of pyrite and other sulfide minerals results in the production of acid and the mobilization of metals. Suggested methods of treatment include the use of air and hydraulic sealing of the mines, lime neutralization of mine effluent, channeling of runoff and mine effluent away from mine and tailing areas, and the grading and sealing of mine dumps.

666412 PB-282 440/7
Assessment of Research and Development Needs and Priorities for Acid Mine Drainage Abatement
Gleason, Virginia E. ; Price, Andrea ; Boyer, Jr., James F. ; Ford, Charles T.
Bituminous Coal Research, Inc., Monroeville, Pa.
Corp. Source Codes: 058470
Report No.: BCR-L-822; BuMines-OFR-44-78
Feb 78 168p
NTIS Prices: PC A08/MF A01 Journal Announcement: GRAI7819
Contract No.: J0265044

Recommendations are made for programs to develop workable techniques to stop or to prevent acid mine drainage formation in these underground coal mines where acid production could take place. These recommendations include development of mine closure technology, development of surface water infiltration control procedures, study of the effect of roof collapse on mine water characteristics, evaluation of the long-term effects of flooding underground mines above drainage, investigation of the effectiveness of section sealing in active mines, development of a simple model for predicting mine water quality and quantity, preparation of a manual on mine drainage abatement procedures, and development of a program to disseminate information on mine drainage abatement to the coal industry. These recommendations are based on an indepth evaluation of information acquired over years of research on acid mine drainage formation, on numerous laboratory and field studies of methods of preventing or minimizing acid mine drainage formation, and on review of the geological, hydrological, and mineralogical factors involved.

658060 CONF-7710113-
Third Symposium on Coal Preparation. NCA/BCR Coal Conference and Expo IV
National Coal Association, Washington, D.C.
Corp. Source Codes: 9500412; 9500469
Sponsor: Bituminous Coal Research, Inc., Monroeville, Pa.; Department of Energy.
1977 288p
Symposium on coal preparation, Louizville, KY, USA, 18 Oct 1977.
Document Type: Conference proceeding
NTIS Prices: PC A13/MF A01 Journal Announcement: GRAI7819 ; NSA0300

The third Symposium on Coal preparation, sponsored by the National Coal Association and Bituminous Coal Research, Inc., was held at the Kentucky Fair and Exposition Center, Louisville, Kentucky, October 18-20, 1977. Fourteen papers from the proceedings have been entered individually into EDB and ERA; five additional papers had been entered previously from other sources. Topics covered involved chemical comminution and chemical desulfurization of coal (aimed at reducing sulfur sufficiently with some coals to meet air quality standards without flue gas desulfurization), coal cleaning concepts, removing coal fines and recycling wash water, comparative evaluation of coal preparation methods, coal refuse disposal without polluting the environment, spoil bank reprocessing, noise control in coal preparation plants, etc. (ERA citation 03:034467)

658099 CONF-7710112-
Seventh Symposium on Coal Mine Drainage Research. NCA/BCR Coal Conference and Expo IV
National Coal Association, Washington, D.C.
Corp. Source Codes: 9600412; 9500463
Sponsor: Bituminous Coal Research, Inc., Monroeville, Pa.; Department of Energy.
1977 264p
Symposium on coal mine drainage research, Louisville, KY, USA, 18 Oct 1977.
Document Type: Conference proceeding
NTIS Prices: PC A12/MF A01 Journal Announcement: GRAI7819 ; NSA0300

The Seventh Symposium on Coal Mine Drainage Research, sponsored by the National Coal Association and Bituminous Coal Research, Inc., was held at the Kentucky Fair and Exposition Center, Louisville, Kentucky, October 18-20, 1977. Seventeen papers from the proceedings have been entered individually into EDB and ERA. Topics covered include chemical reactions of pyrite oxidation and acid formation in spoil banks, abandoned mines, etc., formation of small acid lakes from the drainage and their neutralization by natural and other neutralization measures, trace elements in acid mine drainage, ground water contamination, limnology, effects of surface mined ground reclamation and neutralization, water purification and treatment, mining and coal preparation plant waste disposal, ash and fly ash disposal (to minimize leaching from the wastes), runoff from large coal storage stockpiles during storms (prevention of environmental effects by collection and neutralization by passing through an ash pond). (ERA citation 03:034410)

690353 PB-280 180/1
Site Selection and Design for Minimizing Pollution from Underground Coal Mining Operations
(Final rept. Jun 74-Dec 76)
Shotts, Reynold Q. ; Sterett, Eric ; Simpson, Thomas A.
Alabama Univ., University. Coll. of Engineering.
Sponsor: Industrial Environmental Research Lab., Cincinnati, Ohio.
Report No.: EPA/600/7-78/006
Jan 78 111p
NTIS Prices: PC A06/MF A01 Journal Announcement: GRAI7816
Contract No.: EPA-68-03-2015

The objectives of this study were to determine how best to select a layout and mining system and also to develop and operate an underground coal mine while at the same time minimizing pollution of the environment. The pre-mining environment was assessed by sampling Cedar Creek 3 and other streams. Analyses of samples of groundwater into the mine, of the water pumped from the mine sump, and of water from Cedar Creek below the mine, made possible the assessment of the area with regard to water quality. Principal factors associated with mining which affected downstream water quality were sulfide oxidation and acid formation in the mine, the quality of the groundwater seeping into the mine, the limestone used for rock dusting, and the quality of the resettled but not treated mine and washing plant water carried to the continuous miners for dust suppression. Deep mines in Alabama's synclinal coalfields, if entered some distance from the outcrop, or mined down-dip if started on the outcrop, should produce little surface pollution.

630598 NTIS/PS-78/0113/7
Bacterial Pollution of Water. Volume 2. February, 1976-February, 1978 (A Bibliography with Abstracts)
(Rept. for Feb 76-Feb 78)
Harrison, Elizabeth A.
National Technical Information Service, Springfield, Va.
Corp. Source Codes: 391812
Feb 78 201p
Supersedes NTIS/PS-77/0118, NTIS/PS-76/0120 and NTIS/PS-75/-129. See also Volume 1, 1964-Feb 76, NTIS/PS-77/0117.
Document Type: Bibliography
NTIS Prices: PC N01/MF N01 Journal Announcement: GRAI7809

These selected abstracts of research reports cover bacteria, especially coliform bacteria, found polluting natural bodies of water, mine water, sewage effluents, and water used in food processing. (This updated bibliography contains 196 abstracts, 114 of which are new entries to the previous edition.)

627457 CONF-770862-1
Microbial Ecology of Coal Mine Refuse
Cameron, R. E. ; Miller, R. M.
Argonne National Lab., Ill.
Corp. Source Codes: 0448000
Sponsor: Energy Research and Development Administration.
1977 61p
International symposium on microbial ecology. Dunedin, New Zealand, 22 Aug 1977.
Document Type: Conference proceeding
NTIS Prices: PC A04/MF A01 Journal Announcement: GRAI7806 ; NSA0600
Contract No.: W-31-109-ENG-38

Baseline microbial and ecological studies of samples obtained from two abandoned coal mine refuse sites in the State of Illinois indicate that the unfavorable nature of refuse materials can be a very limiting factor for survival and growth of organisms. Despite the ''foothold'' obtained by some microorganisms, especially acidophilic fungi and some acidotolerant algae, the refuse materials should be amended or ameliorated to raise the pH, provide needed nutrients, especially nitrogen, and provide biodegradable organic matter, both for physical and biological purposes. Finally, the role of microbial populations, responses, and interactions in acid mine wastes must be put into larger perspective. Acid mine drainage amounts to over 4 million tons per year of acidity from active and abandoned mines. Microorganisms appear to be significantly responsible for this problem, but they also can play a beneficial and significant role in the amelioration or alleviation of this detrimental effect as abandoned mines are reclaimed and returned to useful productivity. (ERA citation 03:007886)

623417 LA-UR-77-1880
Environmental Pollution by Trace Elements in Coal Preparation Wastes
Williams, J. M. ; Wewerka, E. M. ; Vanderborgh, N. E. ; Wagner, P. ; Wanek, P. L.
Los Alamos Scientific Lab., N.Mex.
Corp. Source Codes: 3820000
Sponsor: Energy Research and Development Administration.
Report No.: CONF-771024-1
1977 11p
NCA/BCR coal conference, Louisville, Kentucky, USA, 19 Oct 1977.
Document Type: Conference proceeding
NTIS Prices: PC A02/MF A01 Journal Announcement: GRAI7806 ; NSA0300
Contract No.: W-7405-ENG-36

Coal preparation waste contains a multitude of leachable elements. Data for 18 elements are presented here. Generally these elements occur in the waste leachates at levels related to their occurrence in the water. Closer inspection reveals, however, that some elements are much more leachable than others. Thus, for Illinois-Basin waste iron is found to be present in waste leachate in high amounts, but this amount represents only a small percentage of the total iron in the waste. Cobalt and nickel, on the other hand, are not very plentiful in the waste, but are highly leachable. Aluminum, a major constituent of clays in the waste, is very poorly leached. Oxygen availability is a prime factor in the production of soluble iron which is readily flushed from the waste. Particle size is less important. Under damp conditions and with plenty of air, pyrite oxidizes rapidly. This latter situation poses a problem for the plant operator, as coal preparation wastes are discarded damp and remain so via rainstorms for long periods before they are covered. (ERA citation 03:002165)

692519 COO-2758-2
Strip Mine Reclamation: An Island Biogeographical and Ecosystem Energetic Approach. Progress Report, June 1, 1976--May 31, 1977
Carrel, J. E. ; Kucera, C. L. ; Harrison, Jr., A. P. ; Blanchar, R. W.
Missouri Univ., Columbia.
Corp. Source Codes: 4277000
Sponsor: Energy Research and Development Administration.
Feb 77 33p
NTIS Prices: PC A03/MF A01 Journal Announcement: GRAI7719 ; NSA0200
Contract No.: EY-76-S-02-2758

Study sites were established in west central Missouri, the major mining area of the state. Biotic inventories in central Missouri were largely completed and detailed analyses of specimens and data derived from them are underway. Floristic studies in western Missouri were also initiated. Acidification of fresh mine spoil occurred in 8 months under controlled laboratory conditions. The role of bacteria and abiotic factors in spoil aging continues to be studied. Vegetative cover measurements made from aerial photographs of central Missouri mines between 1938 and 1976 indicate revegetation in hilly, acidic mines tends to follow a logistic pattern (r = 0.97) and hence, it can be relatively fast (90 percent cover in 32 to 100 yr), contrary to previous predictions. Find-grained analysis of island communities showed mutual exclusion of woody and herbaceous species, which suggests plants themselves might slow the successional process. Litter samples placed on the ground within and outside herbaceous vegetation had rapid loss of weight and radioactive carbon (t/sub exp 1 / sub 2 / = 1 yr) during the latter part of 1976. Artificial habitat islands consisting of sections of prairie hay bales were established in two mines. Preliminary evidence from one set of hay islands suggests that several prairie species became established in about 25 percent of the units after 1 year. (ERA citation 02:033651)

561433 NTIS/PS-77/0118/6
Bacterial Pollution of Water. Volume 2. February 1976-February 1977 (A Bibliography with Abstracts)
(Rept. for Feb 76-Feb 77)
Harrison, Elizabeth A.
National Technical Information Service, Springfield, Va.
Corp. Source Codes: 391812
Mar 77 87p
Supersedes NTIS/PS-76/0120, and NTIS/PS-75/129.
Document Type: Bibliography
NTIS Prices: PC N01/MF N01 Journal Announcement: GRAI7709

These selected abstracts of research reports cover bacteria, especially coliform bacteria, found polluting natural bodies of water, mine water, sewage effluents, and water used in food processing. (Contains 82 abstracts) See also NTIS/PS-77/0117, Bacterial Pollution of Water. Vol. 1. 1964-February 1976.

561432 NTIS/PS-77/0117/0
Bacterial Pollution of Water. Volume 1. 1964-February 1976 (A Bibliography with Abstracts)
(Rept. for 1964-Feb 76)
Harrison, Elizabeth A.
National Technical Information Service, Springfield, Va.
Corp. Source Codes: 391812
Mar 77 211p
Document Type: Bibliography
NTIS Prices: PC N01/MF N01 Journal Announcement: GRAI7709

The volume of selected abstracts of research reports covers bacteria, especially coliform bacteria, found polluting natural bodies of water, mine water, sewage effluents, and water used in food processing. (This updated bibliography contains 206 abstracts, none of which are new entries to the previous edition.)

554170 PB-260 245/6
Report on Pollution of Interstate Waters of the Mouth of the Savannah River Georgia-South Carolina
West, A. W. ; Runes, C. E. ; Fairall, J. M. ; Westler, T. A.
Robert A. Taft Sanitary Engineering Center, Cincinnati, Ohio
Nov 64 93p
NTIS Prices: PC A05/MF A01 Journal Announcement: GRAI7707

The lower 28 miles of the Savannah River flowing past the industrial area of Chatham County and Savannah and into the Atlantic Ocean were surveyed. These waters once supported commercial American shad and oyster fisheries, but because of pollution discharged to the river, the waters were closed to shellfishing. Data are presented on water uses, sources of wastes (sewage, industrial wastes, oxygen-demanding wastes, and acid wastes), dispersion of wastes, bacterial pollution, oxygen demand and dissolved oxygen, oil pollution, and radioactivity.

530020 FE-1218-2
Study of Coal-Associated Wastes Resulting from the Mining, Processing, and Utilization of Coal. Quarterly Report No. 14, May 10, 1975--August 9, 1975
West Virginia Univ., Morgantown. Coal Research Bureau.
Corp. Source Codes: 9501366
Sponsor: Energy Research and Development Administration.
Sep 75 19p
NTIS Prices: PC A02/MF A01 Journal Announcement: GRAI7625 ; NSA0100
Contract No.: E(49-18)-1218

The production of 40 percent cored area flyash brick from one lignite and two bituminous coal flyashes is described. The effect of varying the sodium silicate content and other process variables on the brick production tests is also discussed. Improved mixing techniques for the production of reproducible aerated concrete specimens is discussed along with the current status of the sulfur removal program, the recovery of metals from acid mine drainage and the potential for removing S in coal by bacterial action. (ERA citation 01:012428)

538287 PB-287 297/2
Processes, Procedures, and Methods to Control Pollution from Mining Activities
Penn Environmental Consultants, Inc., Pittsburgh, Pa.
Sponsor: Skelly and Loy, Harrisburg, Pa.; Environmental Protection Agency, Washington, D.C. Office of Air and Water Programs.
Report No.: EPA/430/9-73/011
Oct 73 390p
Prepared in cooperation with Skelly and Loy, Harrisburg, Pa.
Document Type: Bibliography
NTIS Prices: PC A16/MF A01 Journal Announcement: GRAI7624
Contract No.: EPA-68-01-1830

The report provides information on processes, procedures, and methods to control pollution resulting from mining activities. The control methods included in the report are identified and described by way of brief text, generalized illustrations, and unit cost indications where possible. An extensive bibliography is appended with appropriate referencing in the description of each pollution control method. The publication has been prepared to be a general overview of available pollution control techniques. The described techniques should be considered as potential alternatives for specific mining pollution problems. The applicability of any method or combination of methods will depend upon many factors including climatic, geologic, engineering, economic, land use and aesthetic considerations. The usual case will be that a combination of techniques will be required to effect the elimination or reduction of the discharge of pollutants from mining sources. The control measures described are conceivably applicable to mining sources of pollutants regardless of whether those sources are categorized as 'point' or 'non-point' sources. The control measures and pertinent experience citations selected for inclusion result largely from studies and pollution control technology development that have occurred in association with coal mining pollution problems in the eastern U.S. Cost data are shown where appropriate to indicate a broad range of costs for individual control measures. Any use of quoted costs should be limited to gross estimation for planning purposes.

491668 NTIS/PS-76/0120/6
Bacterial Pollution of Water (A Bibliography with Abstracts)
(Rept. for 1964-Feb 76)
Harrison, Elizabeth A.
National Technical Information Service, Springfield, Va.
Corp. Source Codes: 391812
Mar 76 211p
Supersedes NTIS/PS-75/129.
Document Type: Bibliography
NTIS Prices: PC N01/MF N01 Journal Announcement: GRAI7609

The selected abstracts of research reports cover bacteria, especially coliform bacteria, found polluting natural bodies of water, mine water, sewage effluents, and water used in food processing. (This updated bibliography contains 206 abstracts, 58 of which are new entries to the previous edition.)

448819 PB-241 143/7
Removal of Manganese from Mine Drainage by Ozone and Chlorine
(Final rept.)
Rozelle, Ralph B. ; Swain, Jr, Howard A.
Wilkes Coll., Wilkes-Barre, Pa.
Corp. Source Codes: 378800
Sponsor: National Environmental Research Center, Cincinnati, Ohio.
Report No.: EPA/670/2-75-006
Mar 75 87p
NTIS Prices: PC A04/MF A01 Journal Announcement: GRAI7513
Contract No.: EPA-R-801236

This research was directed toward an examination of methods by which coal mine water could be treated for removal of manganese. In order to remove manganese from mine water, strong oxidizers must be employed to oxidize it to the (+4) oxidation state in which it is relatively insoluble and will precipitate as MnO2. Both ozone and hypochlorite ion were effective in this oxidation and reduced manganese concentrations to less than 2 mg/l and in some cases to less than 0.05 mg/l. Reaction orders based on initial reaction rates are reported for the manganese (II) at pH values of 2, 4, 6 and 7.9 in the time intervals studied. Solubilities of both manganese (II) hydroxide and manganese (IV) oxide were measured. Cost data were developed for both the ozone and sodium hypochlorite treatment.

435642 NTIS/PS-75/129/7
Bacterial Pollution of Water (A Bibliography with Abstracts)
(Rept. for 1964-Nov 1974)
Harrison, Elizabeth A.
National Technical Information Service, Springfield, Va.
Jan 75 182p
Document Type: Bibliography
NTIS Prices: PC N01/MF N01 Journal Announcement: GRAI7506

The bibliography contains 147 selected abstracts covering bacteria, especially coliform bacteria, found polluting natural bodies of water, mine water, sewage effluents, and water used in food processing.

389188 PB-231 160/3
Summary of Water Quality Standards for Interstate Waters of the Commonwealth of Pennsylvania
Pennsylvania Dept. of Environmental Resources, Harrisburg. Bureau of Sanitary Engineering.
Report No.: DOC-42-001
Oct 71 60p
NTIS Prices: PC A04/MF A01 Journal Announcement: GRAI7412

The purpose of these standards is to protect the public health and welfare and enhance the quality of the nation's interstate waters to serve a variety of beneficial uses, such as public water supply, recreation, protection of aquatic life, industrial, and agricultural uses. This publication summarizes the standards for the general information of the public and Federal, State, and local officials as to the uses and associated requirements for interstate waterways of Pennsylvania. The general aim in designating uses for particular interstate waters is to recognize present uses and practicable future uses; to provide where possible for a variety of uses; and to assure compatibility of standards with Federal, State, and local resource planning.

388671 PB-230 314/7
Mine Drainage Treatment State of the Art and Research Needs
Hill, Ronald D.
Federal Water Pollution Control Administration, Cincinnati, Ohio.
Corp. Source Codes: 388275
Dec 68 102p
NTIS Prices: PC A06/MF A01 Journal Announcement: GRAI7412

This report reviews the current status of treatment methods for mine drainage and outlinew those areas needing further research and development.

363198 PB-224 931/6
Gas Requirements to Pressurize Abandoned Deep Mines
(Environmental protection technology series)
Robins, John D.
Environmental Protection Agency, Washington, D.C.
Corp. Source Codes: 380139
Report No.: W74-00836; EPA-670/2-73-064
Aug 73 199p
Prepared by Rice (Cyrus Wm.), Pittsburgh, Pa. Sponsored in part by Commonwealth of Pennsylvania.
Paper copy available from GPO $2.00 as stock no. EP1.23:670/73-064.
NTIS Prices: PC-GPO/MF A01-NTIS Journal Announcement: GRAI7401
Contract No.: EPA-14010-EFL

The objective of this study was to determine the gas injection rates needed to develop and maintain slight pressures within a mine over ambient conditions during changes in the barometric pressure. The ultimate aim of the project was to determine the feasibility of blanketing an abandoned deep mine with an inert gas in order to eliminate the acid mine drainage. Pressurization tests were conducted at two typical abandoned deep mine sites in southwestern Pennsylvania. The study also included a state-of-the-art evaluation of existing technology which could be used to locate points of gas leakage from deep mines. The findings of this literature survey were implemented in several full-scale leak detection experiments. (Modified author abstract)

332657 PB-219 264/9
Organic Wastes as a Means of Accelerating Recovery of Acid Strip-Mine Lakes
(Completion rept., 1 Jul 70-30 Jun 72)
King, Darrell L. ; Simmler, Joseph J.
Missouri Water Resources Research Center, Columbia.
Report No.: W73-07808; OWRR-A-038-MO(1)
20 Feb 73 70p
NTIS Prices: PC A04/MF A01 Journal Announcement: GRAI7313
Contract No.: DI-14-31-0001-3225; DI-14-31-0001-3525; OWRR-A-038-MO

The study determines the role of metals in the natural and accelerated recovery of strip-mine waters from the time of acid formation on the pyrite crystal to the time of lake recovery. A host of acid dissociated ionic species, including iron, sulfate, hydrogen, aluminum, manganese, calcium, and magnesium, and allochthonous organic materials characterize the chemistry of these lakes. The metal buffers are responsible for the long natural recovery times associated with all acid strip-mine lakes. The amount of such buffers depends upon the amount and type of clays and minerals dissolved on the spoil banks. The recovery rate of such lakes is dependent on the availability of carbon sources for sulfate reducing bacteria to use as food while they 'titrate' the acidity by releasing H2S to the atmosphere until all buffers are exhausted.

329865 PB-214 876
Sulfide to Sulfate Reaction Mechanism. A Study of the Sulfide to Sulfate Reaction Mechanism as it Related to the Formation of Acid Mine Waters
Smith, E. E. ; Shumate, K. S.
Ohio State Univ. Research Foundation, Columbus.
Corp. Source Codes: 267360
Feb 70 129p
Prepared in cooperation with Federal Water Pollution Control Administration.
Paper copy available from GPO $1.50 as stock no. EP2.10:14010 FPS-02/70.
NTIS Prices: PC-GPO/MF A01-NTIS Journal Announcement: D7301
Contract No.: FWPCA-14010-FPS

A detail study of the mechanisms and kinetics of the chemical reactions responsible for acid mine drainage is discussed. The mineralogical features of the solid phase reactant (pyrite) that determine its reactivity were described. The rate-limiting reactions and variables affecting the rate of these reactions were identified. It was found that two basic oxidation modes are important: oxygenation, in which oxygen is the immediate oxidizing agent; and ferric ion (or microbiologically catalyzed) oxidation, in which ferric ions are the oxidants. From a knowledge of the dissolved oxygen, ferric/ferrous ratio, and total iron ion content at the reaction site, the reaction regime can be determined. Kinetic equations were derived for both reaction modes. From these basic relationships the oxidation rate in real pyritic systems can be accurately predicated when conditions at the reaction site are known. (Author)

316752 PB-214 771/8
Pilot Scale Study of Acid Mine Drainage
Ohio State Univ. Research Foundation, Columbus.
Corp. Source Codes: 267360
Report No.: W73-05216; EPA-WQO-14010-EXA-03/71
Mar 71 85p
Paper copy available from GPO $1.00 as EP1.16:14010EXA03/71.
NTIS Prices: PC-GPO/MF A01-NTIS Journal Announcement: GRAI7307
Contract No.: DI-14-12-97; EPA-WQO-14010-EXA

In order to study pyrite oxidation and resulting acid mine drainage, a research facility was developed using a small, long-abandoned drift mine and six 33 inch diameter auger holes drilled in order to have comparable, isolated, experimental 'mines' on a pilot scale basis. Experimental data and observations of the effect of oxygen concentration on acid production have shown the location of major reaction zones and indicated that bacterial catalysis of pyrite oxidation is not a significant factor in production of acid mine drainage. When the correspondence between holes has been established, one hole will be used as a reference mine so that fluctuations due to hydrologic variations can be separated from effects of experimentally imposod changes in the other holes.

314760 PB-214 485/5
Metabolic Role of Sulfates and Sulfides Producing Bacteria in Pollution of Waters
(Research rept. Jul 68-Jun 70)
Aleem, M. I. H.
Kentucky Water Resources Inst., Lexington.
Report No.: RR-46; W73-04567; OWRR-A-016-KY(1)
Dec 71 61p
NTIS Prices: PC A04/MF A01 Journal Announcement: GRAI7306
Contract No.: DI-14-01-0001-1636; OWRR-A-016-KY

Since the activities of sulfur bacteria are known to be responsible for many of the characteristics of acid-mine wastes, investigations were aimed at elucidating the physiology and metabolism of these bacteria as this approach appears to be the key to the development of control measures. The investigations show that thiobacilli are the most prolific producers of sulfates from the oxidation of sulfur compounds. Under laboratory conditions, an average population of thiobacilli was found. Assuming that the rate of sulfur transformation in natural environments having enrichment of these organisms is approximately 10% of the transformations observed under laboratory conditions, then the thiobacilli could produce as much as 100 to 400 moles of sulfates in one hour in the upper one foot of water in an area of one acre. However concentrations as low as 0.000001 to 10 to the minus seventh power of chloro or bromo-substituted phenols were effective in the complete inhibition of the energy metabolism of thiobacilli.

312208 PB-213 938/4
Biological Treatment of Acid Mine Water
(Final rept.)
Rabolini, Franco ; Rice, Philip A.
Syracuse Univ., N.Y. Dept. of Chemical Engineering and Materials Science.
Corp. Source Codes: 406796
Jul 71 83p
NTIS Prices: PC A05/MF A01 Journal Announcement: GRAI7305
Contract No.: EPA-WP-01460-01

A strain of Desulfovibrio Desulfuricans was used to test the feasibility of treating acid mine water biologically. Sulfate reduction rates were measured with lactate media at different temperatures, influent pH, and sulfate concentrations in batch and continuous reactors. Among the several additional organic substrates tested, digester sludge appears to be the most attractive because of its low cost and its neutralizing properties. Sulfate reduction in mixtures of acid mine water and digester sludge were demonstrated in a semi-continous reactor and the sulfate reduction rates were measured. The controlling factors of sulfate reduction are discussed.

310364 PB-213 887/7
Pyritic Systems: A Mathematical Model
Morth, Arthur H. ; Smith, Edwin E. ; Shumate, Kenesaw S.
Ohio State Univ. Research Foundation, Columbus.
Corp. Source Codes: 267360
Report No.: EPA-R2-72-002; W73-03506
Nov 72 169p
Paper copy available from GPO $2.25 as EP1.23/2:72-002.
NTIS Prices: PC-GPO/MF A01-NTIS Journal Announcement: GRAI7304
Contract No.: EPA-14-12-589; EPA-14010-EAH

A mathematical model of an acid mine drainage system has been developed for underground mines. The model relates the rate of acid formation to the rate of pollution discharge from the system. The calculational model was developed using a digital computer to simulate an existing mine as the sum of many micro scale mines. The input to the model is a physical and chemical description of the system. Day-to-day simulation requires data on temperature, rainfall, and oxygen concentration at the exposed coal face. The output of the model is estimates of daily acid load and drainage flow. The calculational model was based on a carefully described physical model so that a predictive model can be constructed with little or no experimental data. However, methods for constructing the computational model are given which can use the field data available to increase the reliability.

302211 PB-213 006/0
Inorganic Sulfur Oxidation by Iron-Oxidizing Bacteria
(Water pollution control research series)
Lundgren, Donald G.

Report No.: W73-01609; EPA-14010-DAY-06/71
Jun 71 156p
Paper copy available from GPO $1.25 as EP2.10:14010DAY06/71.
NTIS Prices: PC-GPO/MF A01-NTIS Journal Announcement: GRAI7301
Contract No.: EPA-14010-DAY

Sulfur metabolism of Thiobacillus ferrooxidans and rhodanese-sulfite oxidase enzymes were studied. As disclosed by electron microscope examination, the purified cell envelope of lipopolysaccharide contains a very high quantity of ferric iron. A new colorimetric whole cell assay was developed to study iron oxidation. The presence of pyrophosphatase enzyme was revealed for the first time in chemolithotrophic microorganisms. Study of energy soruces disclosed that the chemolithtrophic T. ferrooxidans can evolve heterotrophic mechanisms and grow on glucose, following the Entner-Doudoroff pathway. (Author)

297230 PB-212 377
Physiology of Acidophilic Bacteria of Acid Mine Water
(Completion rept. Jul 69-Aug 70)
Manning, Herbert L. ; Cook, Thomas M.
Maryland Univ., College Park. Water Resources Research Center.
Report No.: W72-14793; OWRR-A-016-MD(2)
Feb 72 57p
NTIS Prices: PC A04/MF A01 Journal Announcement: GRAI7223
Contract No.: OWRR-A-016-MD

Two new acidophilic bacteria (strains M-1 and M-2) were isolated from coal mine waters, characterized, and placed in the genus Pseudomonas, as Pseudomonas acidophila, sp. n. Obligate acidophiles unable to grow at neutrality, they are capable of rapid and vigorous growth at pH 3.5, with a range of pH 2.5-4.5, in an especially devised yeast extract-glucose salts medium. Unlike the ferrobacilli and thiobacilli, they are heterotrophs rather than autotrophs. They differ from other acid-tolerant heterotrophic bacteria of such environments in being obligate acidophiles and fail to grow on routine bacteriological culture media. Various morphological and physiological characteristics of the two strains were determined. A low level of yeast extract (0.025-0.050%) stimulates growth, but growth is progressively inhibited above 0.1%. Both inorganic and organic nitrogen sources are utilized for growth. Growth with ammonium salts lowered the pH of the medium but growth with organic nitrogen sources such as L-histindine, hydrolyzed casein or urea consistently raised the pH from an initial value of 4.0 to 5.0 or higher.

256806 PB-206 231
Microbiological Treatment of Acid Mine Drainage Waters
(Water pollution control research series)
Continental Oil Co., Ponca City, Okla. Research and Development Dept.
Report No.: W72-04100; EPA-WQO-14010-ENW-09/71
Sep 71 85p
Paper copy available from GPO $1.00 as EP2.10:14010 ENW 09/71.
NTIS Prices: PC-GPO/MF A01-NTIS Journal Announcement: GRAI7207
Contract No.: EPA-WQO-14010-ENW

The purpose of the study was to determine if the abilities of certain bacteria to oxidize ferrous iron or to convert sulfate to hydrogen sulfide could be applied to the neutralization and subsequent removal of iron from difficult-to-treat mine drainage waters. If one or both of these concepts could be successfully utilized, the expense of adequately treating these types of problem waters might be significantly reduced. Laboratory studies demonstrated that both pure cultures and fresh field cultures of acidophilic iron bacteria could readily oxidize ferrous iron in both synthetic and natural acid mine drainage waters. Approximate requirements of oxygen, carbon dioxide, nitrogen and phosphorus by the iron bacteria were established. Limestone neutralizations of partially oxidized acid mine waters were conducted. Although sulfate-reducing bacteria were isolated, attempts to grow the cultures or produce hydrogen sulfide at pH values below 5.5 were unsuccessful.

256880 PB-206 123
Influence of Acid Mine Water on the Microflora of Sewage
Cook, Harold A. ; Wilson, Harold A.
West Virginia Univ., Morgantown. Water Research Inst.
Report No.: WRI-WVU-71-02; BULL-3; W72-03531; OWRR-A-002-WVA(4)
1971 31p
Pub. as West Virginia Univ. Bull. Ser-72, no. 5-1, Nov 71.
NTIS Prices: PC A03/MF A01 Journal Announcement: GRAI7206
Contract No.: OWRR-A-002-WVA

Millions of gallons of acid mine drainage enter our water courses every hour killing or retarding the growth of the flora and fauna. The problem is compounded when these water courses are also receiving domestic sewage. As a result of the low pH, environmental conditions develop which are unfavorable for all but a few acid tolerant strains (capable of multiplying) of bacteria. A reduction and/or selection of the microbial population takes place; bacteria mostly disappear and yeasts and filamentous fungi become the predominant forms of microorganisms. The bulletin reports the data obtained: (a) from a study of the microflora of the acid mine water-domestic sewage polluted Monongahela River; (b) from a study of the effects of acid mine drainage on the microorganisms in domestic sewage; and (c) from a determination of the amino acids present in raw sewage which could serve as nutrients for the microflora in the receiving waters. (Author)

244554 PB-203 679
The Effects of Various Gas Atmospheres on the Oxidation of Coal Mine Pyrites
(Water pollution control series)
Robins, John D. ; Troy, Joseph C.
NUS Corp., Pittsburgh, Pa. Cyrus Wm. Rice Div.
Report No.: W72-00081; EPA-WQO-14010-ECC-08/71
Aug 71 148p
Paper copy available from GPO $1.25 as stock no. 5501-0111.
NTIS Prices: PC-GPO/MF A01-NTIS Journal Announcement: GRAI7124
Contract No.: FWPCA-14-12-877; EPA-WQO-14010-ECC

Experiments up to 150 days in length were conducted to study the acid production rate of coal mine pyrites under various gas atmospheres. The gas atmospheres studied were air, nitrogen, methane, and carbon dioxide. The lower limits of the oxidation process were studied by introducing small amounts of oxygen along with the inert blanketing gas and by studying the effects of deaerated versus air saturated feedwater. Acid production was proportional to the available oxygen partial pressure. The acid parameters monitored continued to change and had not completely reached a steady state by the termination of the work. The acid production of nitrogen blanketed pyrite decreased to less than 1% of that of identical columns under air atmosphere. Nitrogen and methane gases were equally effective in reducing acid production. Both of these gases were slightly more effective than carbon dioxide. A large amount of detailed experimental data is presented. (Author)

225603 PB-199 835
Acid Mine Drainage Formation and Abatement
(Water Pollution Control Research series)
Ohio State Univ. Research Foundation, Columbus.
Report No.: EPA-DAST-42; W71-08591; EPA-14010-FPR-04/71
Apr 71 89p
NTIS Prices: PC A05 MF A01 Journal Announcement: GRAI7115
Contract No.: EPA-14010-FPR
The report pertains to at-source control of pyrite
oxidation. The current level of knowledge of acid mine
drainage formation is critically reviewed, with emphasis on
reaction kinetics and reactant and product transport. A
reaction system model is developed which provides a conceptual
framework for subsequent discussion dealing specifically with
the physical, chemical, and biological characteristics of
pyritic systems encountered in mining situations. Practical
considerations of at-source control of acid mine drainage
formation in underground mines, spoil banks, and refuse piles
are presented. Deficiencies in current knowledge include:
Descriptions of the physical environment existing at pyrite
oxidation sites in natural systems are far more incomplete
that the current understanding of pyrite oxidation kinetics;
Oxygen transport is poorly described at this time, but is
probably the rate-controlling factor in most instances;
Serious questions exist as to the effectiveness of air-sealing
techniques as currently practiced; The significance of
bacterial catalysis of pyrite oxidation under field conditions
has not been established. (Author)

219023 PB-198 523
Evaluation of Pyritic Oxidation by Nuclear Methods
(Research rept.)
Baker, Robert A.
Carnegie-Mellon Univ., Pittsburgh, Pa.
Corp. Source Codes: 409586
Report No.: W71-07137; EPA-WQO-14010-F11-03/71
Mar 71 39p
Paper copy available from SOD $0.50 as EP
2.10:14010F1103/71.
NTIS Prices: PC-SOD/MF A01-NTIS Journal Announcement:
GRAI7112
Contract No.: FWPCA-14010-FII; EPA-WQO-14010-FII
Laboratory studies demonstrated the feasibility of using the
Mossbauer effect and a backscattering mode of detecting 14.4
Kev gamma rays to spectroscopically monitor the oxidation
processes taking place on pyrite materials. A cobaltous oxide
form of cobalt-57 was the radiation source. Spectra were
obtained of pyritic surfaces under 2 mm of water.
Differentiation of nonoxidized and oxidized pyritic surfaces
was possible with further separation of the spectra to show
individual oxidation product peaks suggesting ferric hydroxide
anJ ferric sulfate. (Author)

201164 PB-196 113

Microbiological Factor in Acid Mine Drainage Formation. II.
Further Observations from a Pilot Plant Study
(Water pollution control research series)
Baker, Robert A. ; Wilshire, Albert G.
Mellon Inst., Pittsburgh, Pa.
Corp. Source Codes: 225300
Report No.: W71-02278; FWQA-14010-DKN-11/70
Jul 70 81p
Paper copy available from Superintendent of Documents, GPO,
Washington, D.C. 20402. $0.70 as I67.13/4:14010-DKN-11/70.
NTIS Prices: PC SOD MF A01 Journal Announcement:
USGRDR7103
Contract No.: FWQA-14010-DKN
The role of chemoautrophic organisms in the formation of
acid mine drainage from pyritic materials associated with coal
mining has been investigated by pilot plant techniques.
Dynamic flow, controlled environment units which served as
models of mines were used. It was demonstrated that the
concentration of acidity, ferrous and total iron and sulfate
in the effluent from aerobic, biologically-seeded or unseeded
pyritic beds is zero order with respect to flow, except at low
flow rates where mass transport is diffusion limited. Algal
growth occurred in the acidic, aerobic environment but did not
affect acid production. Nonaerobic systems produce acidity
consisting only of ferrous iron. Total acidity is lower from
biologically-seeded then -nonseeded aerobic systems. Acid mine
drainage was not significantly affected by seeding with the
individual or a mixture of three different organisms but was
increased by recycle of the flow and increased appreciably
under forced aeration. The rate is directly related to the
available pyrite surface area. (WRSIC abstract)

197586 PB-195 285

Stream Pollution in the 'New Lead Belt' of S. E. Missouri

(Completion rept., Jul 68-Jun 70)

Wixson, Bobby G. ; Chen Hong-Wen

Missouri Water Resour[illegible]esearch Center, Columbia.

Report No.: W71-0062[illegible]-A-021-MO(1)

Aug 70 23p

NTIS Prices: PC [illegible] A01 Journal Announcement: USGRDR7101

Contract No.: DI[illegible]1-1845; DI-14-31-001-3026; OWRR-A-021-MO

The project studied [illegible]ts of lead-zinc mining and milling pollution in the [illegible] rend or 'New Lead Belt' of S.E. Missouri. Results [illegible] from the project included the following: Stream pollution below the mine discharge was mainly due to the growth of large algal mats of Oscillatoria and bacteria which appear to result from the discharge of sodium isopropyl xanthate in the milling waste water; Limits were established for the precipitation of lead, zinc, and copper in relationship to pH and other water quality parameters; The amount of fluorides, in the streams may be used as an indicator of mining water discharges; New techniques may be used to evaluate organic milling reagents in the water and in the biota; Diatoms may be used as biological indicators of mine waste water effects. (WRSIC abstract)

167559 PB-189 401

Effect of an Acid-Water Environment Upon the Synthesis of Growth Factors (Vitamins) by Bacteria

Wilson, H. A. ; Richardson, Jr, Keister L.

West Virginia Univ., Morgantown. Water Research Inst.

Report No.: INFORMATION-1; W70-00312; OWRR-A-014-WVA(1)

1969 12p

NTIS Prices: PC A02 MF A01 Journal Announcement: USGRDR7006

Contract No.: OWRR-A-014-WVA

Five bacterial isolates capable of growing in a synthetic medium with no vitamins or growth factors were used. Three of the isolates were obtained from Monongahela River water (an acid mine water-sewage polluted stream) and two from untreated domestic sewage. The minimum growth pH for two isolates was 3.7 and for the others it was 3.5. A synthetic medium was prepared, dispensed, and adjusted either to minimum growth pH or 0.2 unit below the minimum growth pH. To various portions of the medium amino acids, vitamins, fatty acids, peptone, yeast extract, soil extract, sterilized domestic sewage and a hydrolyzed protein were added singly and in combinations. Except for one combination of two additives, no increase in growth occurred at the minimum pH. With this combination better growth occurred at minimum pH level than in the control (no additives) with the five bacteria. There was some indication with one isolate growth was obtained in the presence of the additives at 0.2 pH unit below the previously determined minimum growth pH. pH determinations were made before and after medium modification, and before and after incubation to ensure no incorrect interpretations because of a pH shift. (Author)

162703 PB-188 823

Survival and Activity of Sewage Micoorganisms in Acid Mine Water

(Research rept.)

Kraluvic, Raymond C. ; Wilson, H. A.

West Virginia Univ., Morgantown. Water Research Inst.

Report No.: RR-1; W69-08400; OWRR-A-002-WVA(2)

1969 38p

NTIS Prices: PC A03 MF A01 Journal Announcement: USGRDR7005

Contract No.: OWRR-A-002-WVA

Numbers and types of bacteria decrease if the pH of sewage is lowered by addition of acid mine water. A rapid decrease occurs at 4 C and 22 C, but at 22 C microbial numbers increase after the initial decrease. The biochemical oxygen demand (BOD) of sewage and acid-mine-water mixtures decreases as the pH of the mixture decreases. At pH 3.5, there is a lag period before much biochemical oxidation occurs. Oxygen utilization is greater if yeasts are inoculated into a sterile sewage and acid-mine-water mixture than when bacteria are used. If together, utilization is greater than for either alone. Qualitative and quantitative microbial estimations were made on Monongahela River water which contains domestic raw sewage and acid mine water. Yeasts were the dominant organisms if the plating medium was at pH 4.0, and bacteria were dominant if the medium was about pH 7.0. The actually acid-tolerant bacteria that will grow in sewage and acid-mine-water mixtures at pH 4.0 probably represent only a few genera. Four such isolates were identified as Bacillus species. Although each had characteristics of both B. coagulans and B. firmus, characteristics were sufficiently different to prevent positive identification. Other isolates were identified as Micrococcus candidus and Kurthia variabilis. (Author)

D

APPENDIX D

NATIONAL TECHNICAL INFORMATION SERVICE (NTIS) DATABASE

SEARCH #4 OF 4

SEARCH STRATEGY:

[ACID MINE DRAINAGE OR MINE ACID DRAINAGE OR MINE WASTE(S) OR MINE WATER(S)]

AND

[LEACHING]

NOT

[SEARCH #1 OR 2 OR 3]

1013961 PB83-252233
Evaluation of Acid-Mine-Water Generation and Acid-Mine-Drainage Potential of Coal and Coal-Associated Rocks
Renton, John J.
West Virginia Univ., Morgantown. Water Research Inst.
Corp. Source Codes: 015448033
Report No.: W83-09820; OWRT-A-044-WVA(1)
Aug 83 9p
Languages: English
NTIS Prices: PC A02/MF A01 Journal Announcement: GRAI8326
Country of Publication: United States
Contract No.: DI-14-34-0001-2152; A-044-WVA

Control or prevention of the drainage of acid mine water into streams is perhaps the greatest water problem in West Virginia and in the coal-mining areas of the region. After many years and much effort, the basic characteristics of the material, generally accepted as pyrite, that yields the acid is still not adequately understood. Planning, management, and control of this toxic pollutant are hindered without a sufficient understanding of the mechanisms of acid formation. This project was a small part of a continuing research effort of the principal investigator to gain a sufficient understanding of the mechanisms of mine-acid formation.

1004037 DE82019584
Ion-Exchange Fibers for Uranium Recovery. Final Report, September 8, 1980-November 8, 1981
Babcock, W. C.
Bend Research, Inc., OR.
Corp. Source Codes: 057701000; 9510162
Sponsor: Department of Energy, Washington, DC.
Report No.: DOE/ER/10738-1
18 Dec 81 29p
Languages: English
NTIS Prices: PC A03/MF A01 Journal Announcement: GRAI8223 ; NSA0600
Country of Publication: United States
Contract No.: AC06-80ER10738

Development was initiated of ion-exchange fibers that could be used to extract uranium ions from solutions containing 10 ppM uranium or less, such as acid mine waters, leach solutions, various natural groundwaters, and perhaps even seawater. These fibers would ultimately be used to make large, loosely woven mats that could be placed in dilute solutions or uranium. Periodically, the mats would be removed and stripped of uranium with an appropriate solution. Two major approaches to making these fibers were investigated. One involved incorporating conventional amine solvent-extraction reagents into the pores of microporous, polysulfone fibers. This approach was unsuccessful due to a rapid loss of the reagents from the fibers. The second approach was to incorporate water-swollen gels of polymeric amines into the pores of the fibers. These fibers effectively extracted uranium from solutions containing 10 ppM uranium. An economic analysis based on the projected costs of mats made from these fibers and on the value of the uranium recovered by the fibers shows that the mats could be used to economically recover uranium from dilute solutions and that they offer a substantial cost advantage over conventional ion exchange. (ERA citation 08:038489)

948842 PB83-138010
Leachability and Revegetation of Solid Waste from Mining
(Final rept. Oct 79-Nov 81)
Apel, M. Lynn
Industrial Environmental Research Lab.-Cincinnati, OH.
Corp. Source Codes: 050490000
Report No.: EPA-600/2-82-093
Nov 82 179p
Languages: English
NTIS Prices: PC A09/MF A01 Journal Announcement: GRAI8305
Country of Publication: United States

This research study was conducted to assess the effectiveness in pollution abatement of various mining solid waste disposal strategies. Column studies were undertaken to evaluate the quality and quantity of leachate generated by the disposal of a pyrite mine waste under various soil amelioration and layering configurations and to assess the vegetative uptake of potentially hazardous materials from the solid waste. Columns containing the mine waste under one to four feet of cover soil were used to assess the capability of the cover material in reducing leachate volume, improving leachate quality, and enhancing vegetative growth. The results of this study illustrated that the quality of leachate resulting from the disposal of a pyrite mine waste may be dramatically improved by incorporating lime, sewage sludge, and fertilizer into the upper strata of the mine waste, layering sewage sludge and fertilizer on top of the lime-treated mine waste, or by covering the mine waste with a relatively heavy layer of cover soil.

894500 PB82-157876
Delineation of Acid Mine Drainage Potential of Coal-Bearing Strata of the Pottsville and Allegheny Groups in Western Pennsylvania
(Technical completion rept.)
Hornberger, Roger J. ; Parizek, Richard R. ; Williams, Eugene G.
Pennsylvania State Univ., University Park. Dept. of Geosciences.
Corp. Source Codes: 003282146
Sponsor: Office of Water Research and Technology, Washington, DC.
Report No.: W82-03884; OWRT-B-097-PA(1)
Nov 81 360p
Languages: English
NTIS Prices: PC A17/MF A01 Journal Announcement: GRAI8210
Country of Publication: United States
Contract No.: DI-14-34-0001-7182; OWRT-B-097-PA

The goal of the research was to test the relationship between paleoenvironment and acid mine drainage production on a regional basis. Coal mining data from 23 counties, or approximately 285 quadrangles, were obtained from mine drainage permit records, and a computer program was written to map these data. More than 150,000 lines of water-quality data were retrieved from the STORET data base, from which contour maps and trend surface maps were constructed. A computer program was developed to compare the water-quality and coal mining data using a grid cell structure.

842698 ORNL/TM-7337
Laboratory and Field Analysis of Factors Affecting Quality of Leachate from Coal Storage Piles
Davis, E. C. ; Boegly, Jr., W. J. ; Tamura, T.
Oak Ridge National Lab., TN.
Corp. Source Codes: 021310000; 4832000
Sponsor: Department of Energy, Washington, DC.
Mar 81 308p
Thesis. Submitted by E.C. Davis to Vanderbilt Univ., Nashville, TN.
Languages: English
NTIS Prices: PC A10/MF A01 Journal Announcement: GRAI8116 ; NSA0600
Country of Publication: United States
Contract No.: W-7405-ENG-26

It is the purpose of this research to investigate the potential environmental problems associated with the runoff from coal storage facilities and to suggest methods of circumventing the acidic leachate. Specifically, controlled laboratory and field-scale experiments have been carried out which identify and investigate various factors believed to be influential in determining leachate quality. These factors, including coal type (high or low sulfur content), exposed coal surface area, storage moisture conditions, rainfall intensity, frequency, and duration have all been suggested as being important in determining leachate quality and are discussed in detail. An examination of reported data from Illinois Number 6 and Montana Rosebud coals indicates that a direct comparison of leachate from laboratory-scale column leaching experiments does not adequately predict the quality of leachate which occurs from larger volumes of the same type of coal stored under natural field conditions. Comparisons of leachate quality between laboratory and field-scale experiments could only be made after the data had been normalized, based on the weight of coal in storage and the ratio of rainfall volume to unit coal surface area. It is recommended, therefore, that in laboratory experiments designed to simulate the leachate from actual coal storage piles, the rainfall volume per unit time be identical to expected field conditions and the exposed coal surface area be adjusted so that the ratio of rainfall volume to unit area of coal surface be similar to that occurring in the actual coal pile. (ERA citation 06:013352)

839868 PB81-177483
Monitoring Groundwater Quality: The Impact of In-situ Oil Shale Retorting
Slawson, Jr, Guenton C.
General Electric Co., Santa Barbara, CA. TEMPO.
Corp. Source Codes: 010792006
Sponsor: Environmental Monitoring Systems Lab., Las Vegas, NV.
Report No.: GE78TMP-103; EPA-600/7-80-132
Jun 80 320p
Languages: English
NTIS Prices: PC A14/MF A01 Journal Announcement: GRAI8115
Country of Publication: United States
Contract No.: EPA-68-03-2449

This report presents the initial phase of a research program which will develop a planning methodology for the design and implementation of cost-effective groundwater quality monitoring programs for modified in-situ (MIS) oil shale retorting. This initial phase includes (1) a review of MIS development with regard to potential impacts and a review of current MIS monitoring programs, and (2) identification of key issues, uncertainties, and unknowns with regard to design and implementation of monitoring programs.

788395 PB80-221967
Static Coal Storage - Chemical Effects on the Aquatic Environment
Coward, Nathan A. ; Horton, Joseph W.
Wisconsin Univ.-Superior.
Corp. Source Codes: 032400000
Sponsor: Environmental Research Lab.-Duluth, MN.
Report No.: EPA-600/3-80-083A
Aug 80 88p
Languages: English
NTIS Prices: PC A05/MF A01 Journal Announcement: GRAI8025
Country of Publication: United States
Contract No.: EPA-R-806287-02-0

The aqueous leaching of heavy metals from soft coal has been examined under a variety of conditions. Variables examined were pH, particle size, rate of flow, time of contact, and oxygen or nitrogen atmosphere. Simple leaching of coal from Western mines with pure water does not remove large amounts of metal. Metal removed was in most cases about 0.1% to 0.5% of the total metal in the coal. Extended, successive leaches (of about one week duration) and leaches in a mildly acid (acetic acid-acetate buffer; pH approximately equals 4.7) tended to remove larger amounts of some metals. Leaching with a strong complexing agent removes relatively larger amounts of metal. When placed in contact with water previously spiked with metal ions, the coal actually reduces the aqueous concentration of many metal ions.

794222 PB80-216757
Effects of Underground Coal Mining on Ground Water in the Eastern United States
(Final rept. Sep 76-Sep 79)
Sgambat, Jeffrey P. ; LaBella, Elaine A. ; Roebuck, Sheila
Geraghty and Miller, Inc., Annapolis, MD.
Corp. Source Codes: 068424000
Sponsor: Industrial Environmental Research Lab.-Cincinnati, OH.
Report No.: EPA-600/7-80-120
Jun 80 201p
Languages: English
NTIS Prices: PC A10/MF A01 Journal Announcement: GRAI8024
Country of Publication: United States
Contract No.: EPA-68-03-2467

This report addresses the past effects and the possible future effects of underground coal mining activities on ground-water resources in the region east of the 100th meridian. Such effects are highly dependent on the location of the mine with respect to natural flow system. Recharge-discharge relationships in the vicinity of active mines may be altered, and lowered ground-water levels may not recover to pre-mining conditions after closure. Studies indicate that contamination of ground water exists in many places in the immediate vicinity of coal mines. Many refuse piles and impoundments likely affect stream and shallow ground-water quality. From the viewpoint of the value of ground-water resources, it is most likely that future underground mining in the Eastern Interior Basin and the southern Appalachians will result in adverse ground-water effects in only very limited areas.

777906 LA-8240-MS
Trace Element Characterization and Removal from Coal and Coal Wastes
Wagner, P. ; Williams, J. M. ; Bertino, J. P. ; Wangen, L. E. ; Wanek, P. L.
Los Alamos Scientific Lab., NM.
Corp. Source Codes: 016457000; 3823000
Sponsor: Department of Energy, Washington, DC.
Feb 80 18p
Languages: English
NTIS Prices: PC A02/MF A01 Journal Announcement: GRAI8018 ; NSA0500
Country of Publication: United States
Contract No.: W-7405-ENG-36

The FY 1980 research in this program is broken down into four tasks: environmental control technology for trace elements in coal waste drainages, assessment of trace element contamination in coal waste drainages in the Appalachian Region, assessment of trace element contamination and characterization of leaching potential of coal slurry wastes, and assessment of nature and magnitude of trace element contamination in drainages from western coal wastes. These tasks, objectives, and methods are discussed. (ERA citation 05:014720)

777848 LA-7831-PR
Trace Element Characterization of Coal Wastes. Third Annual Progress Report, October 1, 1977-September 30, 1978
Wewerka, E. M. ; Williams, J. M. ; Wangen, L. E. ; Bertino, J. P. ; Wanek, P. L.
Los Alamos Scientific Lab., NM.
Corp. Source Codes: 016457000; 3820000
Sponsor: Department of Energy.
Report No.: EPA-600/7-79-144
Jun 79 92p
Microfiche copies only.
Languages: English
NTIS Prices: MF A01 Journal Announcement: GRAI8018; NSA0600
Country of Publication: United States
Contract No.: W-7405-ENG-36

In 1978, we performed laboratory experiments to investigate the efficacy of several control options for treating coal wastes at the preparation plant or during disposal. Our research revealed that calcining is one of the more effective and permanent means of treating high-sulfur coal wastes before disposal to decrease, quite dramatically, the release of environmentally undesirable pollutants into the drainages from disposal sites. Another promising control method is codisposal of the coal wastes with lime or limestone to neutralize the acid drainage and retain soluble aqueous contaminants within the waste site. Other experiments have examined the feasibility of using natural sealants, such as clays, soils, calcite, and cements, to isolate the disposal site from its immediate environment. The various tradeoffs for these control options are discussed in terms of contaminant reduction, complexity, permanency, and cost. We have begun an assessment of coal preparation wastes from the Appalachian region. Based on the work we have done on refuse from a single plant, it is clear that coal wastes containing a low percentage of pyrite plant, it is clear that coal wastes containing a low percentage of pyrite (< 1 %) generate worrisome amounts of acid drainage. Our experimental results show that the trace elements of environmental concern in the leachates from these low-sulfur wastes are aluminum, manganese, iron, nickel, and copper when their concentrations are in excess of the Environmental Protection Agency's recommended Minimum Acute Toxicity Effluent (MATE) values. (ERA citation 05:009600)

773898 LA-8039-MS
Costs of Coal and Electric Power Production: The Impact of Environmental Control Technologies for Coal-Cleaning Plants
Thode, E. F. ; Williams, J. M. ; Wewerka, E. M. ; Wagner, P.
Los Alamos Scientific Lab., NM.
Corp. Source Codes: 016457000; 3820000
Sponsor: Department of Energy, Washington, DC.
Oct 79 25p
Languages: English
NTIS Prices: PC A02/MF A01 Journal Announcement: GRAI8017; NSA0600
Country of Publication: United States
Contract No.: W-7405-ENG-36

Costs of 10 alternative environmental control technologies were calculated for three hypothetical and three actual cleaning plants. The cost of lime-limestone slurry coating ranged from $0.22 to $0.50 per ton of product coal. For one actual plant cleaning high-sulfur coal, the range of costs for the 10 alternatives was from $0.076 to $9.69 per ton of product coal, based on March 1978 costs. For the purpose of supplying electric utility customers, coal cleaning reduces the cost of meeting environmental standards because it is less expensive (potentially) to control the water pollution from the coal-cleaning plant than the air pollution from the utility power plant. Applying the less expensive environmental control technology options to coal-cleaning wastes adds approximately 0.2 to 0.4 mills/kWh to the costs of electric power production. (ERA citation 05:013023)

730799 METC/RI-79/3
Kinetics and Reaction Products of Aerobic Pyrrhotite (FeS) Hydrolysis at Ambient Temperatures
Case, G. D. ; Farrier, W. L. ; Green, D. A. ; Stewart, G. W.
Department of Energy, Morgantown, WV. Morgantown Energy Technology Center.
Corp. Source Codes: 9507780
Mar 79 36p
Languages: English
NTIS Prices: PC A03/MF A01 Journal Announcement: GRAI7924 ; NSA0400

The product distributions and mechanisms of FeS hydrolysis were examined in reference to acid mine drainage, as a function of pH, NH sub 4+ ion concentration, and SO sub 2 /sulfite concentrations in aqueous suspensions. Products in the solution phase as well as precipitates and starting material residues were examined by pH and redox potentiometry, x-ray diffraction, x-ray fluorescence, scanning electron microscopy, infrared spectrometry, and wet chemical methods. Principal products of pyrrhotite hydrolysis included soluble SO sub 4 /sup =/, Fe exp 2+ , and lepidocrocite (FeOOH). In an unbuffered acid medium, equimolar leaching of iron and sulfur from FeS gives these plus some evolved H sub 2 S as the only products. Hydrolysis in unbuffered water yields the same products with the exception of H sub 2 S, with an atom ratio of Fe:S leached of 3.5 to 1. Surface pyrite (FeS sub 2), S exp 0 , and S-rich sulfides are not observed. Hydrolysis in ammonia at pH = 9 gives rise to equimolar FeS leaching to form Fe(OH) sub 2 , FeO(OH), and SO sub 4 /sup =/ as the only products. Hydrolysis in a bisulfite buffer (pH = 6) gives Fe exp 2+ plus lesser amounts of FeO(OH), FeO, and Fe sub 2 (SO sub 4) sub 3 . Thermodynamic and kinetic considerations, extended to present conditions, predict FeO(OH), Fe exp 2+ and SO sub 4 /sup =/ as the principal products. The kinetics of iron sulfide hydrolysis are exceedingly slow. In no case did more than 2 percent of the original FeS leach even after 6 days. (ERA citation 04:042234)

663994 FE-2549-18
Development of Potential Uses for the Residue from Fluidized Bed Combustion Processes. Quarterly Technical Progress Report
Minnick, L. J.
Minnick (L.J.), Inc., Plymouth Meeting, PA.
Corp. Source Codes: 9506889
Sponsor: Department of Energy.
Feb 78 38p
Languages: English
NTIS Prices: PC A03/MF A01 Journal Announcement: GRAI7804 ; NSA0300
Contract No.: EF-77-C-01-2549

Analyses of FBC residues from different installations indicate basic similarities in the range of particle size distribution of spent bed materials, with the exception of the Battelle residue, which is extremely fine-grained. There are, however, some notable differences in the chemical compositions of FBC residues from various sources. Hydration to a dry or wet end point is an effective means of concentrating the lime in the finer fractions of FBC residue. Stabilized road base compositions containing FBC residue and pulverized coal fly ash are capable of developing a substantial amount of compressive strength at relatively low curing temperatures, including impressive strength gains after only one week of curing at below freezing conditions. The durability of these compositions far exceed minimum specification requirements and exhibit considerably higher strengths after vacuum saturation than conventional formulations. While FBC residue does not appear to substantially reduce the plasticity of clay soil, moderate additions do result in significant strength additions to the soil. By proper proportioning of FBC residue and pulverized coal fly ash, concrete masonry units can be produced which are superior, in most respects, to conventional concrete block. Substitution of a portion of the cement used in block manufacture with FBC residue also enhances the economic attractiveness of FBC materials for such use. The cementitious properties of FBC residue/fly ash blends suggest the possibility for cement substitute in portland cement concrete mixtures. Early test results indicate that little in the way of harmful environmental effects can be expected from compositions containing FBC residue, particularly if the material is stabilized with fly ash. (ERA citation 03:054347)

677254 PB-286 886/0
Ground-Water Elements of in situ Leach Mining of Uranium
(Final rept.)
Thompson, W. E. ; Swarzenski, W. V. ; Warner D. L. ; Rouse, G. E. ; Carrington, O. F.
Geraghty and Miller, Inc., Tampa, Fla.
Sponsor: Earth Sciences, Inc., Golden, Colo.; Missouri Univ.-Rolla.; Nuclear Regulatory Commission, Washington, D.C. Div. of Fuel Cycle and Material Safety.
Report No.: NUREG-CR-0311
Aug 78 190p
Prepared in cooperation with Earth Sciences, Inc., Golden, Colo., and Missouri Univ.-Rolla.
NTIS Prices: PC A09/MF A01 Journal Announcement: GRAI7826
Contract No.: NRC-02-77-187

The investigation summarized herein was undertaken in 1977-78 to assist the U.S. Nuclear Regulatory Commission in protection of ground-water resources at sites where in-situ leach mining of uranium is expected to take place. The major objectives of the investigation were to: (1) provide criteria and a methodology for establishing baseline groundwater quality; (2) evaluate methods of restoration and their potential environmental impacts; (3) evaluate excursion control methods and their environmental impacts; (4) develop criteria for selecting excursion and restoration monitoring programs; (5) assess the potential impact of mining and restoration on water use; and (6) determine the potential impacts of disposal of wastes generated during mining and restoration.

677210 PB-286 613/5
Operation of Irigaray Uranium Solution Mining Project, Wyoming Mineral Corporation. Docket No. 40-8502
(Final environmental statement)
Nuclear Regulatory Commission, Washington, D.C. Office of Nuclear Material Safety and Safeguards.
Report No.: NUREG-0481
Sep 78 279p
NTIS Prices: PC A12/MF A01 Journal Announcement: GRAI7826

A *Final Environmental Statement* for Wyoming Mineral Corporation related to application for a source material license for the Irigaray uranium solution mining project to be located in Johnson County, Wyoming (Docket No. 40-8502), has been prepared by the Office of Nuclear Material Safety and Safeguards. This statement provides (1) a summary of environmental impacts and adverse effects of the proposed action, and (2) a consideration of principal alternatives. Also included are comments of governmental agencies and other organizatioons on the Draft Environmental Statement for this project, and staff responses to these comments. The NRC has concluded that, after weighing the environmental, economic, technical, and other benefits of the Irigaray uranium solution mining project against environmental and other costs and considering available alternatives, the action called for is issuance of a source material license subject to conditions stipulated in the license.

674688 PB-284 743/2
Bureau of Mines Research 1977. A Summary of Significant Results in Mining, Metallurgy, and Mineral Economics
(Research summary rept. 1977)
Bureau of Mines, Washington, D.C.
Corp. Source Codes: 068450
Report No.: BUMINES-SP-2-78
1977 146p
See also report dated Dec 76, PB-267 678.
NTIS Prices: PC A07/MF A01 Journal Announcement: GRAI7825

Established in 1910, the Bureau of Mines of the Department of the Interior is the Federal Government's primary research arm in the minerals field. The role of the Bureau of Mines is to develop, through scientific and engineering investigations, improved technology to increase the recovery of coal, copper, and other mineral products from the country's deposits while decreasing energy usage through more efficient processing; to improve the economics of recycling scrap metals; to achieve more efficient utilization of virgin metals and minerals by extending their normal lifespan; and to find industrial uses for the many wastes of mineral processing that constitute unsightly dumps and contribute to air, water, and land pollution. Research 77 is the seventh in a series of annual Bureau of Mines publications high-lighting significant research projects and mineral data studies.

671284 PB-284 013/O
Effects of the Disposal of Coal Waste and Ashes in Open Pits (Final rept.)
Libicki, Jacek
Central Research and Design Inst. for Open-Pit Mining, Wroclaw (Poland).
Sponsor: Industrial Environmental Research Lab., Cincinnati, Ohio.
Report No.: EPA/600/7-78/067
Apr 78 299p
NTIS Prices: PC A13/MF A01 Journal Announcement: GRAI7823
Contract No.: EPA-02-532-10

The objective of this study was to determine the extent of groundwater quality deterioration when coal mine solid waste (refuse) and power plant ashes were disposed of into open pits. In addition, disposal methods were developed and procedures for planning and designing disposal sites were formulated. Pilot studies were conducted at two experimental disposal sites, at which the groundwater was monitored. As backup to these tests, laboratory studies of the physical-chemical properties of the waste, and its leachate were conducted. Based upon the results of these studies, a full scale demonstration was conducted. From this work, the physical-chemical character of the waste material and its susceptibility to leaching of particular ions in a water environment were determined, as was the influence of precipitation on the migration of pollutants (TDS, Cl, SO4, Na, K, Ca, Mg, NH4, PO4, CN, phenols, Cd, Sr, Cu, Mo, and B) to the aquifer. The level of pollution of groundwater in the vicinity of disposal sites and its dependence on local hydrogeological conditions, and particularly on hydraulic gradients was ascertained. Recommendations for improved waste storage technology in order to limit the effect on groundwater to a minimum and guidelines for designing a monitoring system are presented. (Portions of this document are not fully legible)

669836 CONF-780213-3
Water Quality Implications of Increase Coal Use
Habegger, L. J. ; Chiu, S. Y. ; Dauzvardis, P. A. ; Gasper, J. R.
Argonne National Lab., Ill.
Corp. Source Codes: 0448000
Sponsor: Department of Energy.
1978 14p
107. AIME meeting, Denver, CO, USA, 26 Feb 1978.
Document Type: Conference proceeding
NTIS Prices: PC A02/MF A01 Journal Announcement: GRAI7823 ; NSA0300
Contract No.: W-31-109-ENG-38

This paper considers the potential water quality impacts of future energy scenarios which project an approximate doubling of coal utilization from 1975 to 1985. The major impacts estimated for coal extraction are related to effluents from unregulated activities (reclaimed areas prior to stable revegetation) and pollutants (e.g., metals and ammonia). Where applicable, the EPA effluent guidelines to be in effect by 1983 reduce the impact of individual sources to low levels. For example, total suspended solids and acidic discharges are to be regulated to levels generally below recommended water quality standards for receiving streams. However, implementation of these guidelines, particularly for coal extraction, has not been demonstrated on a wide scale. Water quality is not expected to be a major constraining factor for increasing capacity of coal fired utility and industrial boilers. Water quality control has not been demonstrated on a commercial scale for coal conversion to synfuels, but adequate control technologies appear to be feasible. (ERA citation 03:042182)

658935 ORNL/TM-6261
Fossil Energy Environmental Project. Annual Report, FY 1977
Braunstein, H. M.
Oak Ridge National Lab., Tenn.
Corp. Source Codes: 4832000
Sponsor: Department of Energy.
Apr 78 26p
NTIS Prices: PC A03/MF A01 Journal Announcement: GRAI7819 ; NSA0300
Contract No.: W-7405-ENG-26

During the past year the Fossil Energy Environmental Project has provided technical support to the Fossil Energy Program Administration of the Department of Energy (DOE/FE) in its coal conversion demonstration program. Work was focused in four principal areas: environmental assessment; guidance to demonstration plant contractors regarding environmental obligations; experimental studies of stored solids from coal conversion; and interactive assistance to contractors regarding environmental monitoring needs. Four major documents were prepared, two guidelines for contractors and two environmental analyses. An experimental program using both laboratory and field-scale testing was initiated to study leachates from both stored coal and coal conversion wastes. Technical assistance tasks early in the year consisted primarily of quick-response activities. However, after initial demonstration plant contracts were signed, advisory activities increased--the latter part of the year saw the start of frequent interactions with contractors regarding environmental monitoring of coal conversion demonstration-plant sites. (ERA citation 03:034421)

653306 PB-280 306/8
Vegetative Stabilization of Spent Oil Shales: Vegetation Moisture Salinity and Runoff, 1973-76
(Final rept. Apr 74-Aug 76)
Harbert, III, H. P. ; Berg, W. A.
Colorado State Univ., Fort Collins.
Corp. Source Codes: 088300
Sponsor: Industrial Environmental Research Lab., Cincinnati, Ohio.
Report No.: EPA/600/7-78/021
Feb 78 183p
NTIS Prices: PC A09/MF A01 Journal Announcement: GRAI7817
Contract No.: EPA-R-803058

Disposal of massive amounts of spent shale will be required if an oil shale industry using surface retorting is developed. Field studies were initiated in 1973 on two types of spent oil shale--coarse-textured (USBM), and fine-textured (TOSCO). The objectives of these studies were to investigate surface stability of and salt movement in spent shales and spent shales covered with soil after vegetation has been established by intensive treatment and then left under natural precipitation conditions. The plots were established at low-elevation (1,700 m) and high-elevation (2,220 m) study sites in northwestern Colorado. A good cover of native species was established on all plots by leaching, N and P fertilization, seeding, mulching, and irrigation. High levels of Mo were found in plants grown in the spent shales compared to plants grown in soil. Resalinization occurred following leaching of the TOSCO spent shale. The greatest runoff was from the TOSCO spent shale. Runoff was moderately to highly saline.

653215 ORNL/TM-6304
Experimental Study of Leachate from Stored Solids. Quarterly Report, June 1, 1977--January 1, 1978
Boegly, Jr., W. J. ; Arora, H. S. ; Davis, E. C. ; Rao, R. G. S. ; Wilson, Jr, H. W.
Oak Ridge National Lab., Tenn.
Corp. Source Codes: 4832000
Sponsor: Department of Energy.
Jan 78 28p
NTIS Prices: PC A03/MF A01 Journal Announcement: GRAI7817 ; NSA0300
Contract No.: W-7405-ENG-26

This quarterly report is the first one. The basic aim of the program is to determine the environmental acceptability of landfilling solid residues from coal gasification facilities, and also to evaluate potential environmental degradation caused by leachate produced by rainfall on coal storage piles. This report outlines the program plan, discusses waste types to be studied, provides details of the solid-waste leaching studies, describes existing hydrologic models that can be used for predicting contaminant movement, describes results of a literature review of coal pile runoff, and outlines a laboratory and field program to evaluate coal pile leachate. (ERA citation 03:030125)

653209 ORNL/TM-6186
Review of the Literature on Leachates from Coal Storage Piles
Davis, E. C. ; Boegly, Jr, W. J.
Vanderbilt Univ., Nashville, Tenn.
Corp. Source Codes: 6660000; 4832000
Sponsor: Oak Ridge National Lab., Tenn.; Department of Energy.
Jan 78 45p
NTIS Prices: PC A03/MF A01 Journal Announcement: GRAI7817 ; NSA0300
Contract No.: W-7405-ENG-26

Runoff from coal storage piles associated with coal conversion or combustion facilities may represent a potential source of environmental pollution. This report is an assessment of existing information on coal pile leachate. The assessment indicates that few detailed studies have been conducted to date, and these are limited and the results are highly variable. More detailed long-range studies using various types of coal are recommended. These studies should be carried out both in the laboratory and in field-scale experiments. (ERA citation 03:030170)

640275 LA-7048-PR
Trace Element Characterization and Removal/Recovery from Coal and Coal Wastes. Work Plan, October 1, 1977--September 30, 1978
Wewerka, E. M. ; Williams, J. M.
Los Alamos Scientific Lab., N.Mex.
Corp. Source Codes: 3820000
Sponsor: Department of Energy.
Dec 77 15p
NTIS Prices: PC A02/MF A01 Journal Announcement: GRAI7813 : NSA0300
Contract No.: W-7405-ENG-36

This document describes the research activities for FY 78 for the Environmental Protection Agency (EPA)--Department of Energy (DOE) program on environmental contamination from trace elements in coal preparation wastes. The main objectives of this program are (1) to assess and define the technology options to control or prevent the release of environmentally harmful trace elements in the drainages from high-sulfur coal preparation wastes and (2) to identify the trace elements of greatest environmental concern in the aqueous discharges from selected samples of Appalachian Basin coal refuse, with the aim of delineating suitable pollution control technology or research, development, and demonstration programs. The details of the experimental activities to accomplish these objectives are discussed. (ERA citation 03:016431)

630984 PB-276 085/8
Water Management in Oil Shale Mining. Volume I. Main Text (Final rept.)
Brown, A. ; Schauer, M. I. ; Rowe, J. W. ; Haley, W.
Golder Associates, Inc., Kirkland, Wash.
Sponsor: Bureau of Mines, Washington, D.C.
Report No.: BuMines-OFR-2(1)-78
Sep 77 428p
See also Volume 2, PB-276 086.
NTIS Prices: PC A19/MF A01 Journal Announcement: GRAI7809
Contract No.: J0265019

This report details work performed and results obtained in a study of the water management aspects of oil shale mining and retorting in the Piceance Creek Basin. Three specific sites were investigated, and optimal water management systems for both conventional and in situ extraction processes were generated. Water-related legal and environmental constraints on development were identified and the water management schemes were developed in compliance with these regulations. Limitations on shale oil production implied by limited water supplies were evaluated. Potential basin-wide effects of development were evaluated using a computer model, and mitigation strategies were developed. Recommendations for additional investigation and analyses were presented.

613531 PB-272 912/7
Mining Research Review - An Annual Review of Selected Mining Research Activities of the Bureau of Mines
Church, James C.
Bureau of Mines, Washington, D.C.
Corp. Source Codes: 068450
Report No.: BUMINES-SP-9-77
Aug 77 81p
See also report dated Jul 76, PB-258 438.
NTIS Prices: PC A05/MF A01 Journal Announcement: GRAI7801

The Bureau of Mines research, development, and demonstration programs are directed towards the conservation of our Nation's mineral and fuel resources, the protection of the miner from health and safety hazards, and the control of social and economic costs to help assure a viable mining industry in the United States. Some major advanced mining technology programs discussed in this review cover coal health and safety, metal and nonmetal health and safety, the environment, and technology transfer. A section is also devoted to the international cooperation of the major coal-producing nations of the world that conduct substantial research towards improving coal mining techniques and equipment and developing more positive means to protect the miners from health and safety hazards.

599599 PB-270 080/5

Paleoenvironment of Coal and Its Relation to Drainage Quality

(Final rept. 1 Aug 73-31 Jul 75)

Caruccio, Frank T. ; Ferm, John C. ; Horne, John ; Geidel, Gwendelyn ; Baganz, Bruce

South Carolina Univ., Columbia. Dept. of Geology.

Sponsor: Industrial Environmental Research Lab., Cincinnati, Ohio.

Report No.: EPA/600/7-77/067

Jun 77 121p

NTIS Prices: PC A06/MF A01 Journal Announcement: GRAI7722

Contract No.: EPA-R-802597-02

The acid production potential of a coal was related to its paleoenvironment (environment of deposition) as interpreted from the overlying strata. Within the Appalachian coal field of eastern Kentucky, coals and associated strata were characterized as either back-barrier, lower delta plain or upper delta plain. Samples from various paleoenvironments were analyzed for sulfur content and pyrite types (reactive versus stable). Samples from the back-barrier, lower delta plain sequence had a relatively higher percentage of reactive pyrite than the seams within strata of upper delta plain. Both environments produced coals of similar total sulfur contents and both contained varying percentages of framboidal pyrite. Although reactive pyrite was present in seams of both paleoenvironments, a differing natural water chemistry caused acid mine drainage to be associated with the back-barrier, lower delta plain strata and never with the upper delta plain strata. This study showed that the pyrite distribution and, more importantly, the water chemistry producing acidic or neutral drainages, were correlative with the paleoenvironment of the coals and associated strata.

565040 PB-263 492/1

Potential Impact of the Development of Lignite Reserves on Water Resources of East Texas

(Research project completion rept.)

James, Wesley P. ; Slowey, J. Frank ; Garrett, Robert L. ; Ortiz, Carlos ; Ortiz, Jon

Texas A and M Univ., College Station. Water Resources Inst.

Sponsor: Office of Water Research and Technology, Washington, D.C.

Report No.: TR-78; W77-04297; OWRT-B-199-TEX(4)

Aug 76 183p

NTIS Prices: PC A09/MF A01 Journal Announcement: GRAI7710

Contract No.: DI-14-34-0001-6121; OWRT-B-199-TEX

Potential adverse effects of lignite strip mining and lignite utilization on the hydrology and water quality of East Texas are identified. Studies included (1) monthly water sampling for a one-year period of streams, lakes and wells near the strip-mined areas and at control stations located away from the lignite development; (2) leaching studies of the lignite and overburden at Fairfield and Rockdale; (3) precipitation samples collected under the airborne waste plume from the lignite-fueled electric generating plant at Fairfield; and (4) a limited trace element enrichment study in the soils around the plant at Fairfield.

533501 ERDA-116

Balanced Program Plan: Analysis for Biomedical and Environmental Research. Volume 3. Coal Extraction, Processing, and Combustion

Argonne National Lab., Ill.

Corp. Source Codes: 0448000

Sponsor: Energy Research and Development Administration.

Apr 76 74p

NTIS Prices: PC A04/MF A01 Journal Announcement: GRAI7626 ; NSA0100

Contract No.: W-31-109-eng-38

The ongoing DBER program of research into and assessment of biomedical and environmental effects of coal extraction, processing, and combustion is described. It is part of the current effort to develop a plan for DBER research activities that is integrated across all energy technologies and balanced in the relative emphases given to the different technologies and their environmental effects. For the purpose of establishing research priorities over so extensive an effort, it has been judged necessary to group research projects into broad program units. These program units are described, including objectives, scope, milestones, and costs. (ERA citation 01:018591)

530021 FE-1218-3

Study of Coal-Associated Wastes Resulting from the Mining, Processing, and Utilization of Coal. Quarterly Report No. 15, August 10, 1975--November 9, 1975

West Virginia Univ., Morgantown. Coal Research Bureau.

Corp. Source Codes: 9501366

Sponsor: Energy Research and Development Administration.

Jan 76 13p

NTIS Prices: PC A02/MF A01 Journal Announcement: GRAI7625 ; NSA0100

Contract No.: E(49-18)-1218

An examination of a simple leaching method to reduce the soluble mineral content of flyashes and a proposed soluble mineral contents monitoring method are discussed. Although both proved unsuccessful, the experimental work has indicated that the problem may not be as simple as previously supposed. A way of producing more consistent aerated concrete products is discussed in more detail and process limitations in the recovery of copper values from acid mine drainage are presented. (ERA citation 01:012430)

468258 PB-244 848/8
Shallow Ground Water in Selected Areas in the Fort Union Coal Region
(Open file rept)
Northern Great Plains Resource Program, Denver, Colo.
Sponsor: Geological Survey, Helena, Mont.
Report No.: NGPRP/CD-74/201; USGS/OFR-74/38
1974 134p
NTIS Prices: PC A07/MF A01 Journal Announcement: GRAI7523

Three sample areas are analyzed to determine potential pollution impacts of surface mining on the shallow ground water systems. Areas analyzed were in the southeastern portion of North Dakota, the Gillette area of Wyoming and the Decker-Birney area of Montana. They were selected as representative of areas where accelerated coal mining is likely to occur. The analyses indicates there will be: (1) Localized disruptions of aquifers; (2) drainage of adjoining clinker beds; (3) drainage of aquifers in immediate vicinity of mines; (4) underlying aquifers will be little affected; (5) possible increase in nitrate and sulphate concentrations in mine waters; and most importantly (6) contamination of the water resource by dissolved material leached from strip-mining spoils. All problems except pollution of ground water from spoils should be minimal after replacement of spoils and rehabilitation. Ground water pollution could be long term.

287216 PB-211 145
Ground Water Pollution in Arizona, California, Nevada, and Utah
(Water pollution control research series)
Fuhriman, Dean K. ; Barton, James R.
Fuhriman, Barton and Associates, Provo, Utah.
Report No.: W72-12193; EPA-16060-ERU-12/71
Dec 71 255p
Paper copya available from GPO $2.00 as EP2.10:16060ERU12/71.
NTIS Prices: PC-GPO/MF A01-NTIS Journal Announcement: GRAI7218
Contract No.: EPA-16060-ERU

An investigation to determine the ground water pollution problems which exist in the states of Arizona, California, Nevada, and Utah was conducted. Data were obtained through an extensive review of the literature and through interviews with engineers, scientists, and governmental officials concerned with water pollution in the four states of the project area. Mineralization of ground water is the most prevalent factor in the degradation of ground water quality in the project area. Large quantities of ground water in each of the four states are undesirable for many uses because of excessive mineralization. Much of the mineralization of ground water is a result of natural processes. A listing of conditions causing ground water pollution in the project area is included.

284974 PB-210 709
Acid Mine Pollution Effects on Lake Biology
(Water pollution control research series)
Smith, Ronald W. ; Frey, David G.
Indiana Univ., Bloomington. Water Resources Research Center.
Report No.: W72-10610; EPA-18050-EEC-12/71
Dec 71 133p
Paper copy available from GPO $1.25 as EP2.10: 18050 EEC 12/71.
NTIS Prices: PC-GPO/MF A01-NTIS Journal Announcement: GRAI7217
Contract No.: EPA-18050-EEC

For greater recreational potential of stripmine lakes, certain fundamental limnological information and the unique water chemistry resulting from leaching of substances contained in the cast overburden of the lakes were investigated. Increasing levels of dissolved oxygen and decreasing concentrations of dissolved substances showed environmental trends in surface waters. These tendencies were somewhat obscured by differences in the annual cycles of stratification, four of the lakes proving to be unexpectedly meromictic. Biological changes associated with increasing pH included increasing diversity and increasing homeostasis. Both pH and circulation patterns (meromixis vs. holomixis) influenced biomass, and bottom fauna was further limited by the steep-sided basin form. All stripmine lakes had much higher solute concentrations and lower biological diversity than a small local non-stripmine reservoir studied as control. Sport fishing in stripmine lakes could be improved by management techniques.

136669 PB-183 647
Experimental Leaching of Gold from Mine Waste
(Report of investigations)
Heinen, H. J. ; Porter, Bernard
Bureau of Mines, Washington, D. C.
Corp. Source Codes: 068450
Report No.: RI-7250
Apr 69 9p
NTIS Prices: PC A02 MF A01 Journal Announcement: USGRDR6913

Excellent gold recovery was demonstrated in a laboratory-scale leaching test on waste material from an open-pit mine in northeastern Nevada. An injection system of leaching was applied in which the sodium cyanide solution was introduced into the interior of the dump at selected points. Dissolution of gold from the waste material, which assayed 0.06 ounce gold per ton, was readily achieved because the gold occurred as submicroscopic particles in a porous host rock. Gold recovery of 80 percent was obtained in 11 days from material crushed to 1 inch in size, and recovery was 90 percent after 21 days. (Author)

E

APPENDIX E

THE ENGINEERING INDEX (COMPENDEX) DATABASE

SEARCH #1 OF 3

SEARCH STRATEGY:

[ACID AND MINE DRAINAGE]

AND

[PYRIT? OR SULPHIDE OR SULFIDE]

1411795 EI8309071795
COAL MINE DRAINAGE IN THE UNITED STATES - AN OVERVIEW.
Lovell, H. L.
Pennsylvania State Univ. Dep of Mineral Engineering, University Park,
Water Sci Technol v 15 n 2 1983, Mine Water Pollut: Proc of a Semin, Pretoria, S Afr, Apr 5-6 1982 p 1-25 CODEN: WSTED4 ISSN: 0273-1223
Languages: ENGLISH

Control approaches to minimize change in water quantity and quality from strata disturbance have evolved in two decades by regulation, industry coordination, and research. A permit system involves pre-mine planning, bonding, inspection, enforcement, and reclamation. Preventive control is sought rather than treatment to meet effluent guidelines. A tonnage production fee funds restoration of abandoned mine conditions. The bases of control are: hydrologic maintenance, sedimentation to reduce particle transport and suspended solids, evaluation of strata alkalinity and sulfide content, and maintenance of an alkaline strata for sulfide stability. 60 refs.

1355326 EI8303015326
OXIDATION OF FERROUS IRON BY ACIDOPHILIC IRON-OXIDIZING BACTERIA FROM A STREAM RECEIVING ACID MINE DRAINAGE.
Noike, Tatsuya; Nakamura, Kanji; Matsumoto, Jun'ichiro
Tohoku Univ, Sendai, Jpn
Water Res v 17 n 1 1983 p 21-27 CODEN: WATRAG ISSN: 0043-1354

The oxidation of ferrous iron by the acidophilic iron-oxidizing bacteria was investigated by field survey and laboratory-scale batch and continuous experiments. The activity of the acidophilic iron-oxidizing bacteria was affected by pH, water temperature and concentration of glucose. The rate of oxidation of pyrite was accelerated by the acidophilic iron-oxidizing bacteria. The number of bacteria attached to the surface of a rotating biological disk changed with the ferrous iron loading. 5 refs.

1175090 EI8109975090
BIOGEOCHEMISTRY OF ACID MINE DRAINAGE AND A METHOD TO CONTROL ACID FORMATION.
Kleinmann, R. L. P.; Crerar, D. A.; Pacelli, R. R.
US Bur of Mines, Pittsburgh, Pa
Min Eng (New York) v 33 n 3 Mar 1981 p 300-305 CODEN: MIENAB ISSN: 0026-5187

A bacterium, Thiobacillus ferroxidans, is of prime importance in the formation of acid drainage from pyritic material. Above pH 4. 5, T. ferrooxidans increases initial acidification; below pH 4. 5, it allows acidification to continue by oxidizing Fe**2** $plus$. Below a pH of approximately 2. 5, the activity of Fe**3** $plus$ results in steady-state cycling between oxidation of pyrite by Fe**3** $plus$ and bacterial oxidation of Fe**2** $plus$. Tests demonstrate that inhibition of T. ferroxidans by controlled release of anionic detergents can inexpensively reduce pyrite oxidation and acid formation. 37 refs.

1141787 EI8105041787
PRODUCTION OF ACID WATER IN A LEAD-ZINC MINE, COEUR D'ALENE, IDAHO.
Wai, C. M.; Reece, D. E.; Trexler, B. D.; Ralston, D. R.; Williams, R. E.
Univ of Idaho, Moscow
Environ Geol (New York) v 3 n 3 1980 p 159-162 CODEN: ENGEDC ISSN: 0099-0094

The Bunker Hill Mine in Idaho's Coeur d'Alene mining district produces approximately 10 m**3/minute of acid water containing high concentrations of heavy metals. Field and laboratory studies indicate that much of the acid water is produced in a single ore body in the upper part of the mine, which contains mainly sphalerite, galena, and pyrite in a siderite-quartz gangue. Ground water recharges this ore body through a near-vertical zone of high permeability, which is the result of mining by the caving technique. Ore samples from the caving area contained oxidized forms of iron and produced acid in a laboratory leaching test. Oxidation of pyrite to sulfuric acid and compounds of iron is apparently responsible for the production of acid water in the mine. Methods for prevention of acid mine drainage in this and other similar mines are noted.

681697 unavailable

604079 EI760104079
OVERVIEW OF USE OF CARBONATE ROCKS FOR CONTROLLING ACID MINE DRAINAGE.
Hill, Ronald D.
US Environ Prot Agency, Cincinnati, Ohio
Forum on Geol of Ind Miner, 10th, Proc, Columbus, Ohio, Apr 17-19 1974 p 26-29. Publ by Ohio Div of Geol Surv (Misc Rep n 1), Columbus, 1974

Acid mine drainage is the result of the oxidation of pyrite and similar iron sulfide material and the release of iron and sulfuric acid into the environment. In addition to the acid water flowing from underground and surface mines, spoil materials in surface mines are acidic and will not support good vegetative growth; thus erosion is a major problem. In this article, lime and limestone are highlighted as the major neutralizing agents used to treat these acidic conditions. Lime is the reagent preferred by industry for treating acid discharges, although a few companies use limestone. Agricultural limestone is used to $left double quote$ sweeten $right double quote$ acid spoils. Refs.

511078 EI750211078
ACID PRODUCTION IN MINE DRAINAGE SYSTEMS.
Smith, Michael J.
Wright State Univ, Dayton, Ohio
Extr of Miner and Energy: Today's Dilemmas. Int Workshop on Environ Probl of the Extr Ind, Pap, Dayton, Ohio, Jun 10-13 1973 Pap 7, p 67-75. Publ by Ann Arbor Sci Publ, Inc, Mich, 1974

An effective method for the prevention of acid production from mine drainage systems can be developed only if an understanding of the kinetics and reactions responsible for acid mine drainage are available. A believable reaction sequence has been described for the dissolution of pyrite in the presence of the appropriate microorganisms and dissolved oxygen, yet little is known about the specific chemical interactions that take place in mine drainage systems. A discussion of the chemistry of such systems is presented in this paper. 17 refs.

311497 EI730311497
ACID MINE DRAINAGE WORKSHOP.
Ahmed, Moid
Ohio Univ, Athens
Ohio Univ Acid Mine Drainage Workshop, Proc, Athens, 1971, Held Aug 2-6, 1971, 167 p

Proceedings contains: presented papers; examination of problems and/or technologies encountered during field trips; and discussion. Among topics covered were: rate of pyrite oxidation and acid production in the field; deep mine sealing; hydrological approach to control acid pollution; the legal framework of acid mine drainage control; acid mine drainage abatement in surface mining; and reclamation of land and of toxic spoilbanks.

227421 EI72X027421
Problem of acid mine drainage in Ontario
HAWLEY JR; SHIKAZE KH
Ontario Water Resources Commission, Toronto
Can Mining J v 92 n 6 June 1971 p 82-4, 89-93 CODEN: CAMJA

Title problem has appeared in Ontario in areas of mining sulfide or sulfide- associated ores. Without exception those orebodies contain quantities of iron sulfide that were rejected in the milling circuits to the tailings area as waste. The content of iron sulfide in those areas was found to be between 2. 5 and 72%. Three mineralogical forms of iron sulfide occurring in the tailings, i. e. , pyrite, marcassite, and pyrrhotite are discussed. Basic chemistry of the acid mine drainage is outlined and discussed. Paper contains ten basic rules for dealing with acid mine drainage. 7 refs.

128019 EI71X028019
Microbiological factor in acid mine drainage formation. A pilot plant study
BAKER RA; WILSHIRE AG
Mellon Inst, Carnegie-Mellon Univ, Pittsburgh, Pa
Environ Sci Technol v 4 n 5 Mar 1970 p 401-7 CODEN: ESTHA

The role of chemoautotrophic organisms in the formation of acid mine drainage from pyritic materials associated with coal mining has been studied by use of pilot plant reactors. Equilibria were achieved under conditions of aeration or nonaeration and biological seeding or nonseeding at specified hydraulic flow rates. If organic carbon is present, heterotrophic organisms may develop in the aerated systems. 14 refs.

F

APPENDIX F

THE ENGINEERING INDEX (COMPENDEX) DATABASE

SEARCH #2 OF 3

SEARCH STRATEGY:

[ACID AND MINE DRAINAGE]

AND

[PYRIT? OR SULPHIDE OR SULFIDE]

AND

[TAILING(S)]

AND

[OXIDIZE OR OXIDIZING OR OXIDATION]

NOT

[SEARCH #1]

1363231 EI8303023231
BACTERIAL OXIDATION OF INORGANIC COMPOUNDS IN MINING WASTES.
Scharer, J. M.; Ibbotson, B.
Univ of Waterloo, Ont, Can
Conserv Recycling v 5 n 1 1982 p 47-53 CODEN: CRECD2 ISSN: 0361-3658
The environmental consequences of chemolithotrophic bacterial activity in uranium tailings basins in Northern Ontario are examined. Pyrite oxidation by Thiobacillus ferrooxidans and ammonia oxidation by Nitrosomonas have been identified as the major sources of pH depression in the affected lakes in the region. 7 refs.

1350625 EI8302010625
IZVLECHENIE ZOLOTA IZ PIRITNOGO KONTSENTRATA TSIANIROVANIEM. $left bracket$ Extraction of Gold from a Pyrite Concentrate by Cyanidation $right bracket$.
Svistunov, N. V.; Makedonova, L. N.
North Caucasus Ore Min & Metall Inst, Ordzhonikidze, USSR
Izv Vyssh Uchebn Zaved Tsvetn Metall n 5 1982 p 55-57 CODEN: IVUTAK ISSN: 0021-3438
It is shown that treatment of a pyrite concentrate according to a scheme which included oxidative-sulfatizing roasting at 500 $degree$ C with thermal decomposition of the iron sulfates and use of the roasting gases for the production of sulfuric acid, leaching of the ash in water to remove water-soluble iron sulfates and nonferrous metals, and cyanidation of the product of water leaching of the ash makes it possible to obtain from comparatively small consumptions of reagents a high yield of gold - of the order of 85-86%, with allowance for losses of unwashed material in the cyanidation tailings. 9 refs. In Russian.

1306602 EI8210066602
CHARACTERISATION STUDIES ON CHITRADURGA COPPER MILL TAILINGS.
Natarajan, K. A.; Tarpara, M. P.; Narayanamurthy, K.
Karnataka Reg Eng Coll, Srinivasnagar, India
Trans Indian Inst Met v 35 n 1 Feb 1982 p 69-73 CODEN: TIIMA3 ISSN: 0019-493X
Studies were made to determine the character and distribution of copper values lost in flotation mill tailings. Acid soluble (oxide) and acid insoluble (sulfide) copper were determined and heavy media separation was used to analyze the sink and float products of different size fractions. Methods to recover the lost copper are outlined.

1136878 EI8104036878
OB USLOVIYAKH VYMYVANIYA MYSH'YAKA IZ OTVAL'NYKH SUL'FIDNYKH PRODUKTOV. $left bracket$ Conditions of the Washing Out of Arsenic from Waste Sulfide Products $right bracket$.
Sedova, V. A.; Vishnyakova, N. N.
Tsvet Met n 9 Sep 1980 p 21-22 CODEN: TVMTAX ISSN: 0372-2929
Under static conditions with free access to an air system, a study was made of the effect of the initial pH of the solution in the range from 4. 0 to 13. 0 and of the effect of the calcium content in the solution on the process of washing out of arsenic, iron, zinc and copper from waste sulfide tailings obtained from the treatment of tin concentrates. It is shown that the presence of calcium in the water has no effect on the oxidation of sulfides, but leads to a decrease in the arsenic, iron and zinc concentrations in the liquid phase in neutral and alkali media. In the range of initial pH's from 4 to 9, which is characteristic of natural waters, no effect of calcium on the accumulation of arsenic, iron, zinc and copper in the liquid phase is noted. 9 refs. In Russian.

1119604 EI8102119604
HYDROCHLORIC ACID LEACHING OF AN ELLIOT LAKE URANIUM ORE.
Haque, K. E.; Lucas, B. H.; Ritcey, G. M.
Dep of Energy, Mines & Resour Ottawa, Ont
CIM Bull v 73 n 819 Jul 1980 p 141-147 CODEN: CIBUBA ISSN: 0317-0926
Hydrochloric acid leaches without an oxidant or with molecular oxygen (i. e. , air or pure oxygen gas) as an oxidant favored uranium and radium extractions. Conditions for maximum uranium, thorium and radium extractions with hydrochloric acid in the presence of sodium chlorate were determined. Flowsheets for two-stage leaching are proposed. The residues obtained from the second-stage leach contain uranium (0. 002%), thorium (0. 006%) and radium (15 to 20 pCi/g). Tailings are suitable for mine backfill, and, if pyrite is removed, suitable for surface disposal. 11 refs.

1050346 EI8007050346
REMOVAL OF PYRITE FROM COAL BY CONDITIONING WITH THIOBACILLUS FERROOXIDANS FOLLOWED BY OIL AGGLOMERATION.
Kempton, A. G.; Moneib, Nayera; McCready, R. G. L.; Capes, C. E.
Univ of Waterloo, Ont
Hydrometallurgy v 5 n 2-3 Feb 1980 p 117-125 CODEN: HYDRDA
Cells of Thiobacillus ferrooxidans are mixed with an aqueous slurry and the mixture is vigorously agitated for as little as 15 min. Pyrite is rendered hydrophilic and is rejected with the tailings when the coal is recovered by oil agglomeration. The bacterial cells can be recovered after agglomeration and used to treat at least six successive batches. 18 refs.

DIALOG

851972 EI780751972
BAKTERIELLE REINIGUNG VON FLOTATIONSWAESSERN. $left bracket$ Bacterial Purification of Flotation Waste Water $right bracket$.
Mueller, Juergen
Metallges, Frankfurt AM, Ger
Erzmetall v 31 n 1 Jan 1978 p 38-41 CODEN: ERZMAK

Sulfides and thiosulfates are impurities which are contained in the waste water of flotation plants, particularly those which process pyrite-containing ores. This article describes the tests conducted to remove the thiosulfate content from the flotation plant's waste water with the help of microbiological processes. From experience gained in bacterial leaching of nonferrous metal-bearing pyrites, it is known that bacteria of the thiobacilli group oxidize sulfur compounds into the sulfate. This principle was employed in a continuously operating pilot plant to remove sulfides and thiosulfates from flotation waste water. In German with English abstract.

844045 EI780844045
FLOTATION OF OXIDIZED MINERALS OF ZINC AND LEAD AFTER HEAT TREATMENT OF ORES.
Stachurski, Jozef
Stanislaw Staszic Univ of Min and Metall, Cracow, Pol
Arch Gorn v 22 n 4 1977 p 427-441 CODEN: AGORAT

This paper presents the results of studies of the floatability of oxidized, low-percentage ores of zinc and lead which are considered to be difficult to treat. Tailings of the flotation of sulfide ores of zinc and lead containing rather large quantities of oxidized zinc are the subject of these studies. About 75% of the zinc in the material occurs in the form of smithsonite while the rest of the zinc occurs in the form of sulfides and a small quantity of zinc dolomite. It was found that neigher conventional methods of ore treatment nor flotation with the aid of sodium sulfide give satisfactory results in the treatment of these ores. To restore to oxidized zinc and lead minerals surface forms more amenable to conventional flotation of sulfide minerals, it is recommended that these head-to-float ores be subjected to prior heat treatment involving the addition of elementary sulfur. Roasting the material with the addition of small quantities of sulfur in a reducing atmosphere causes surface sulfurization of oxidized zinc and lead minerals, as a result of which they become flotable with the aid of xanthates. 22 refs.

816584 EI780316584
DIE OXYDATION IN BASISCHEN SULFID-TRUEBEN UND DIE WIRKUNG DER ENTSTEHENDEN THIOSULFATE AUF DIE FLOTATIONSEIGENSCHAFTEN EINIGER SULFIDE. $left bracket$ Oxidation in Basic Sulfide Pulps and the Effect of the Resulting Thiosulfates on the Flotation Properties of Some Sulfides $right bracket$.
Sandvik, Knut Lyng
Nor Tek Hogsk, Trondheim, Norw
Erzmetall v 30 n 9 Sep 1977 p 391-395 CODEN: ERZMAK

Thiosulfates in the tailings of selective flotation circuits are known as contaminants which require a prolonged treatment. In this study, the formation of thiosulfate, sulfite and sulfide in the solution is investigated. The formation of thiosulfate is found to be dependent on the pH value, oxygen supply, temperature, reaction time and the grain size. The investigations included the discarded pulps of some Norwegian copper/zinc ore dressing plants. In the initial stages of Cu-flotation, thiosulfate content was found to range between 130 and 1120 mg/liter. The results obtained are discussed with special emphasis on the recycling of process water. 8 refs. In German.

809112 EI780209112
NEW OXIDATIVE LEACHING PROCESS USES SILVER TO ENHANCE COPPER RECOVERY.
Snell, G. J.; Sze, Morgan C.
Eng Dev Cent C-E Lumus
Eng Min J v 178 n 10 Oct 1977 p 100-105, 107 CODEN: ENMJAK

A silver-catalyzed, ferric sulfate oxidative leaching that has been developed for copper sulfide ore concentrates is featured here. The process, which is technically vaiable, uses as little as 72 ppm of initially soluble silver catalyst in the leach liquor to enhance significantly the extent and rate of leaching. It also eliminates relatively expensive reagents, pretreatment of concentrates, and recycling of primary tailings. A single-stage copper extraction of more than 97% was obtained in bench tests on a mixed chalcocite-chalcopyrite concentrate after 3 hr of leaching at 195 $degree$ F, with a silver catalyst concentration of 360 ppm. 37 refs.

730824 EI770530824
CUAJONE $EM DASH$ PRODUCING COPPER AT FULL CAPACITY.
Argall, George O. Jr.
World Min v 30 n 1 Jan 1977 p 32-39 CODEN: WOMIAI

The ore body is 468,400,000 tons of 1. 00 percent sulphide copper and 0. 03 percent molybdenum. In addition, there is 22,000,000 tons of oxide assaying 1. 29 percent copper and 106,500,000 tons of leach (both sulphide and oxide). The article describes the mining operation, crushing and concentration plants, tailing disposal, grinding, and classification equipment.

682463 EI761282463
CHEMICAL PROCESSES IN ABANDONED SULPHIDE TAILINGS DUMPS AND ENVIRONMENTAL IMPLICATION FOR NORTHEASTERN NEW BRUNSWICK.
Boorman, Roy S.; Watson, David M.
Res & Prod Counc, Fredericton, NB
CIM Bull v 69 n 772 Aug 1976 p 86-96 CODEN: CIBUBA

Detailed sampling of sulphide tailings from an abandoned dump at Heath Steel Mines Limited and interpretation of the analytical results using Pourbaix-type stability diagrams indicates the presence of three chemical-physical environments within tailings: an Oxidation Zone, extending to a maximum of 30 in. beneath the surface; a Hard Pan, up to 6 in. thick beneath the Oxidation Zone; and a Reduction Zone, the underlying unaltered tailings. Leaching with the Oxidation Zone has removed 76% of the copper and 92% of the zinc to a depth of 10 to 20 in. Galena (PbS) is converted in situ to insoluble anglesite (PbSO//4) and, hence, little lead is removed from the Oxidation Zone. Within the Hard Pan, copper is cemented out as covellite on other base metal sulphides. This has resulted in a 98% increase in copper content over the average 0. 79% copper in the underlying tailings. The results of this study demonstrate that appropriate reclamation procedures for these tailings dumps should be directed at limiting the access of oxygen to the tailings. 5 refs.

680064 EI761280064
PRELIMINARY STUDY OF RELEASE AND REMOVAL OF COPPER AND NICKEL IONS IN MINE AND MILL EFFLUENTS.
Iwasaki, I.; Malicsi, A. S.; Smith, K. A.; Christensen, B. L.
Univ of Minn, Minneapolis
AIME, Minn Sect, 49th Annu Meet and Min Symp, 37th Annu, Proc, Duluth, Jan 14-16 1976 p 26. 1-26. 31. Jointly sponsored by AIME, Minn Sect, New York, NY and Univ of Minn, Miner Resour Res Cent, Minneapolis, 1976

This article summarizes some of the pertinent information in literature on the release and the removal of heavy-metal ions together with cursory experiments performed over the past few years at the Mineral Resources Research Center, and attempts to delineate an experimental program that might be helpful in the development of the copper-nickel resources in northern Minnesota. The potential mining and milling of Duluth gabbro requires that the release of heavy-metal ions via oxidation, though perhaps in minute quantities, must be evaluated. To effectively control the release of these metals the whole system, including mine water drainage, mill effluent and surface drainage, rainfall and evaporation, must be carefully assessed. The individual elements in the system must be studied in detail to determine their relationships to one another. An indication is given that a blending of limestone or marl in small quantities with tailings and waste rock may control the oxidation of sulfide minerals and minimize the acid formation and the release of heavy-metal ions. 33 refs.

625539 EI760425539
REHABILITATION OF AN ABANDONED MINE SITE.
Blezing, N. V.; Lackey, J. A.; Spry, A. H.
Aust Miner Dev Lab, Frewville
Miner and the Environ, Int Symp, Proc, Pap and Discuss, London, Engl, Jun 4-7 1974 p 341-361. Publ by Inst of Min and Metall, London, Engl, 1975

An open-cut pyrites mine was operated for 17 years at Nairne, South Australia, until work ceased in 1972. The ore consisted mainly of pyrite and pyrrhotite (totaling 15%) in a conformable pyritic metasediment. The main environmentally disturbing activities include excavation of a large quarry, formation of waste heaps, emplacement of tailings, release of effluent and the abandonment of mine buildings, plant and houses. The main environmental factors affected include the quality of river and underground water, health and safety, aquatic flora and fish, grazing and the physical properties of aquifers. Rehabilitation consists of the clean-up of all existing plant, the diversion of any surface waters from the mine and tailings dam areas, drainage, stabilization and revegetation of the tailings dam area, collection of all acid effluent to a single treatment point away from the natural drainage, treatment either by oxidation, neutralization and precipitation, disposal of precipitated sludge and the direction of treated water in to the natural stream below the mine workings, or by impounding and natural evaporation. 35 refs.

480378 EI740850378
METHODS AND COSTS FOR STABILIZING FINE-SIZED MINERAL WASTES.
Dean, K. C.; Havens, Richard; Giantz, M. W.
Salt Lake City Metall Res Cent, Utah
US Bur Mines Rep Invest n 7896 1974, 26 p CODEN: XBMIA6

Fine-sized mineral wastes discarded by ore milling plants require stabilization to prevent air and water pollution. Stabilization has been attained by physical, chemical, vegetative, and combination procedures. Vegetative reclamation is preferred to physical and chemical stabilization but is difficult to achieve because the wastes are sterile, contain deleterious inorganic salts, and lack the essential nutrients and physical characteristics required for sustaining vegetative growth. This report summarizes procedures developed by the Bureau of Mines and industry for vegetating amenable tailings, lists costs for the various processes, and suggests procedures that may be applicable for stabilizing saline and pyrite-containing tailings. Ridged planting beds, drip irrigation, and deep-furrow planting techniques are suggested for stabilizing saline wastes. A combination of mill tailings and sewage sludge can be used for producing synthetic soils, and layers of sewage sludge buried under a layer of tailings offer promise of inhibiting acid formation from oxidation of sulfides in mineral wastes. 6 refs.

294287 EI721316288
RECOVERY OF MOLYBDENUM FROM OXIDIZED ORE AT CLIMAX, COLO.
Lane, John W.; Bender, Fredrick N.; Ronzio, Richard A.
Climax Molybdenum Co, Amax, Golden Colo
Trans Soc Min Eng AIME v 252 n 1 Mar 1972 p 77-82

Climax Molybdenum Co. operated a hydrometallurgical plant at Climax, Colo. . from August 1966 to August 1968 to recover molybendum from an oxidized ore. The feed, tailings from sulfide flotation, was first upgraded by cycloning. The concentrate was leached by a sulfuric-sulfurous acid solution at 65 $degree$ C. The molybdenum was solubilized in the form of $left double quote$ molybdenum blue. $right double quote$ Activated charcoal was added to the leach tailings in a resin-in-pulp type circuit. Molybdenum was adsorbed on the charcoal. The charcoal was screened from the pulp and washed. The washed charcoal was pumped to columns where it was ammoniated and air-blown. The oxidized ammonium dimolybdate crystallized out. The ammonium dimolybdate was calcined to molybdenum trioxide.

174136 EI71X174136
Distribution of sulfied and oxide copper in copper mill tailings
WHITE JC; RULE AR
U S Bur Mines, Rep Invest 7498 Apr 1971 19 p CODEN: XBMIA

Studies were made to determine the character and distribution of the copper lost in copper mill tailings. Acid soluble (oxide) and acid insoluble (sulfide) copper were determined for heavy- liquid sink and float products of screen- sized fractions from 12 copper mill tailings. Microscopic examination of heavy- liquid sink products indicated that recovery of liberated copper sulfide minerals is complete in most milles, and that copper minerals not being recovered are locked with gangue particles. Additional copper could probably be recovered from most tailings by sizelassification, scavengen froth flotation of the coarse fraction, and regrinding of the concentrate to achieve liberation of the locked sulfides.

159499 EI71X059499
Solid state physics, advances in research and applications, v 21, 1968
SEITZ ED F; TURNBULL ED D; EHRENREICH ED H
Academic Press Inc, New York, 1968, 513 p

The first three articles of this volume are generally concerned with metal- insulator transitions of various kinds and the transport properties of materials that often exhibit such behavior. The first article is primarily devoted to transition metal oxides, it in fact discusses and develops the theory of electron correlation in narrow band materials which can give rise to metal- insulator transitions on the basis of general viewpoints. The second article deals with a possible excitonic state, characterized by a condensate of excitons which changes the translational symmetry of the original lattice. The third article summarizes the present understanding of polarons, the quasiparticles responsible for the electrical conductivity in the nearly insulating phases of the same kinds of solids as those discussed in the first article. The last contribution treats a rather different subject, the magnetic properties of rare earth metals. It summarizes the variety of equilibrium spin arrangements encountered in the ordered magnetic states of these materials and emphasizes the theory of the excited spin- wave- like states as well as their experimental manifestations and consequences. 5948 000 EI 71 /PHYSICS, Solid State/SEMICONDUCTORS/RARE EARTH ELEMENTS/ //RARE EARTH METALS//TRANSITIONAL METAL OXIDES// //PHASE TRANSITIONS// TIN ORE TREATMENT High- intensity wet magnetic separation of test products from Renison Bell, Tasmania; S. B. HUDSON; Aust, Commonw Sci Ind Res Organ Mining Dep, Univ Melbourne, Ore-Dressing Invest, Rep 673 Sept 1967 4 p; Three tin- bearing samples, representing sulfide flotation tailing, primary cyclone underflow, and low- grade tine concentrate, assaying 5. 2, 0. 9, and 1. 6% Sn respectively were submitted for high-intensity wet magnetic separation. It was stated that pyrrhotite and pistomesite were the major magnetic minerals present. The magnetic concentrates contained 59 to 76% of the iron and 82 to 90% of the sulfur in the test feeds, but they assayed 0. 4 to 2. 3% Sn, representing losses of 11 to 15% of the tin. These losses were higher than expected by entrainment alone, indicating that some cassiterite was assocated with one or more of the magnetic minerals in the test feeds.

019234 EI70X019234
Biological leaching of mill products
DUNCAN DW; WALDEN CC; TRUSSELL PC
British Columbia Research Council, Vancouver
Can Inst Min & Met-%Trans-Min Soc Nova Scotia v 69 1960 p 329-33

Thiobacillus fero- oxidans released copper from 400- mesh chalcopyrite at rate of 54 mg/liter/hr; any flotation chemicals remaining on concentrate did not inhibit leach rate; zinc rougher tailings were also leachable; with bacteria, 75% of zinc and [illegible] of copper came into solution; in sterile controls, only 16% of zinc and 10% of copper were released; 100% of copper and 36% of zinc were leached from pyrite cinders through action of bacteria, and 17% of copper and 10% of zinc were solubilized in sterile controls; less than 0. 027% of iron came into solution; majority of copper in converter slag was acid- soluble, but a reverberatory slag responded to microbiological leaching.

G

APPENDIX G

THE ENGINEERING INDEX (COMPENDEX) DATABASE

SEARCH #3 OF 3

SEARCH STRATEGY:

[PYRIT? OR SULPHIDE OR SULFIDE]

AND

[TAILING(S)]

AND

[OXIDIZE OR OXIDIZING OR OXIDATION]

AND

[BACTERIA?]

NOT

[SEARCH #1 OR 2]

1406276 EI8308086276
MICROORGANISMS EXISTING IN THE CEASED MINES - IRON BACTERIA, SULPHUR BACTERIA AND SULFATE REDUCING BACTERIA.
Kato, Ichiro; Inoue, Katsuyoshi; Moriwaki, Masamitsu
Dowa Mining Co, Jpn
Nippon Kogyo Kaishi v 99 n 1140 Feb 1983 p 105-109 CODEN: NIKKA9 ISSN: 0369-4194
Languages: JAPANESE

Brown and black - hair like or paste like - strange substances can be seen in the drainage and pools of underground workings. The researches about these substances in the undergound of three ceased mines were carried out by following methods; observation of underground state, chemical analysis, cultivation of bacteria and electron probe microanalyzer. The results are as follows. 1. Brown substance contains (1) aerobic iron bacteria and aerobic sulphur bacteria. (2) metalic-oxide, occasionally it contains up to 42% of iron. 2. Black substance contains (1) anaerobic sulfate reducing bacteria mainly and aerobic iron bacteria and aerobic sulphur bacteria also. (2) metalic-sulfide, occasionally it contains up to 15% of copper. Through our researchs, it becomes possible to make these strange substances under artifically-made aerobic and anaerobic circumstances. And by using these artificially-made strange objects, it is possible to improve the extraction technique of heavy metals in the mine drainage. This leads to the improvements of mine-pollution preventing technique, the reduction of its cost and the posibility of recovering the valuable metals from the drainage. In Japanese with English abstract.

1391941 EI8307051941
BAKTERIAL'NO-KHIMICHESKOE VYSHCHELACHIVANIE MEDI IZ OTVALOV KADZHARANSKOGO MESTOROZHDENIYA. $left bracket$ Bacterial-Chemical Leaching of Copper from Wastes of the Kadzharan Deposit $right bracket$.
Aramyan, V. G.; Voskanyan, D. N.
Tsvet Met n 1 Jan 1983 p 21-23 CODEN: TVMTAX ISSN: 0372-2929
Languages: RUSSIAN

The leaching is carried out in two stages: acidic washing and bacterial leaching. The dependence of the rate of copper extraction on the ore grain size is established, and optimal times for extracting the oxidized form of copper (200-300 days) are determined as a function of the type of waste. It is shown that, when leaching the sulfide form of copper, the leaching rate sharply decreases (three - to sixfold, depending on the fraction). In Russian.

1386038 EI8306046038
SEMICONDUCTOR-ELECTROCHEMICAL ASPECTS OF BACTERIAL LEACHING - 2. SURVEY OF RATE-CONTROLLING SULPHIDE PROPERTIES.
Tributsch, H.; Bennett, J. C.
Max-Planck-Gesellschaft, Fritz-Haber-Inst, Berlin, West Ger
J Chem Technol Biotechnol v 31 n 10 Oct 1981 p 627-635
CODEN: JCTBDC ISSN: 0142-0356
Languages: ENGLISH

Sixteen metal sulfides with widely differing solid state, chemical and electrochemical properties have been investigated with respect to their suitability as an energy source for Thiobacillus ferroxidans. The most critical rate-determining parameter for bacterial oxidation (in the absence of any electron acceptors, e. g. Fe**3** $plus$) was the solubility product of the sulfide. Deviations from the systematic dependence are, hoewver, observed when a large concentration of the holes is present in the semiconducting sulfide (p-type conduction), or when holes are generated through electron extraction from the sulfide surface (e. g. by Fe**3** $plus$). The experimental results are consistent with a mechanism in which Th. ferroxidans utilizes H** $plus$ and Fe**3** $plus$ as catalytic agents which break surface bonds by chemical and electrochemical mechanisms, respectively. 9 refs.

1386037 EI8306046037
SEMICONDUCTOR-ELECTROCHEMICAL ASPECTS OF BACTERIAL LEACHING - 1. OXIDATION OF METAL SULPHIDES WITH LARGE ENERGY GAPS.
Tributsch, Helmut; Bennett, Jose C.
Max-Planck-Gesellschaft, Fritz-Haber-Inst, Berlin, West Ger
J Chem Technol Biotechnol v 31 n 9 Sep 1981 p 565-577
CODEN: JCTBDC ISSN: 0142-0356
Languages: ENGLISH

Thiobacillus ferrooxidans has been cultivated successfully on synthetic metal sulfides with large energy gaps (CdS, ZnS) as the only energy source for many culture generations during a period of 4 years. The results obtained, which were quantitatively evaluated by calculations of electron transfer probabilities, show that a direct electron transfer from the metal sulfide valence band to the bacterial metabolic system (hole injection into the valence band of the sulfide) has to be excluded as the cause for the enhanced oxidative dissolution for energetic reasons. A detailed analysis of the dynamics of the metal sulfide aqueous electrolyte interface reveals that protons are involved in the mechanism on which bacterial activity is based. 32 refs.

1380044 EI8306040044
SORPTION OF THIOBACILLUS FERROOXIDANS TO PARTICULATE MATERIAL.
DiSpirito, Alan A.; Dugan, Patrick R.; Tuovinen, Olli H.
Ohio State Univ, Dep of Microbiology, Columbus, Ohio, USA
Biotechnol Bioeng v 25 n 4 Apr 1983 p 1163-1168 CODEN: BIBIAU ISSN: 0006-3592
Languages: ENGLISH

Cell protein was used as a measure of monitoring the sorption of Thiobacillus ferrooxidans to various fine-grain particulates. The materials chosen for the study included both oxidizable substrates and inert particles that were not chemically altered during their exposure to the bacteria suspensions. Factors that may affect the sorption of the cells were tested by experimentation with the use of flowers of sulfur, fluorapatite, glass beads, pyrite, and quartz. Control experiments were included in each test by deleting the particulate material. 17 refs.

1372830 EI8305032830
RECOVERY OF METAL VALUES FROM LOW GRADE COPPER SULFIDE ORES.
Wadsworth, M. E.
Univ of Utah, Salt Lake City, USA
Sep Sci Technol v 16 n 9 Oct 1981, Symp on Sep Sci and Technol for Energy Appl, 2nd, Gatlinburg, Tenn, USA, May 5-8 1981 p 1081-1112 CODEN: SSTEDS ISSN: 0149-6395
Languages: ENGLISH

In the United States approximately 12 percent of the new copper produced comes from dump leaching of low grade waste rock from open pit mining. While this amount of copper is significant it is unusual, even for massive dumps, for steady-state recovery rates to exceed 20 percent. Basic physical and chemical features important in leaching typical copper porphyry waste rock have been determined in laboratory studies in tests involving up to several tons of waste rock. The important findings of such tests including chemistry of extraction, laboratory modeling, energy implications, and recovery from dilute streams are presented. Special emphasis is given to important rate limiting featues of waste rock leaching including the role of autotrophic bacteria in the oxidation sequence. Difficulties in scale up from the laboratory to practice are discussed. 23 refs.

1355326 EI8302015326
OXIDATION OF FERROUS IRON BY ACIDOPHILIC IRON-OXIDIZING BACTERIA FROM A STREAM RECEIVING ACID MINE DRAINAGE.
Noike, Tatsuya; Nakamura, Kenji; Matsumoto, Jun'ichiro
Tohoku Univ, Sendai, Jpn
Water Res v 17 n 1 1983 p 21-27 CODEN: WATRAG ISSN: 0043-1354

The oxidation of ferrous iron by the acidophilic iron-oxidizing bacteria was investigated by field survey and laboratory-scale batch and continuous experiments. The activity of the acidophilic iron-oxidizing bacteria was affected by pH, water temperature and concentration of glucose. The rate of oxidation of pyrite was accelerated by the acidophilic iron-oxidizing bacteria. The number of bacteria attached to the surface of a rotating biological disk changed with the ferrous iron loading. 5 refs.

1340910 EI8301000910
COAL DESULPHURISATION TECHNIQUES - A REVIEW.
Swamy, T. Venkata; Chakrabarti, J. N.
Indian Sch of Mines, Dhanbad
J Mines Met Fuels v 30 n 5 May 1982 p 219-223 CODEN: JMMFAM ISSN: 0022-2755

Attempts have been made for removing sulfate, pyritic and organic sulfur either from coal or from stack gas or both. As a result of these efforts, physical, oxidative, reductive, chemical, solvent refining and bacterial desulfurization processes were proposed. The present article reviews these techniques to show that chemical and bacterial processes have a significant effect on inorganic and organic forms of sulfur using them as leachants. 36 refs.

1289431 EI8208069431
INHIBITORY EFFECTS OF PARTICULATE MATERIALS IN GROWING CULTURES OF THIOBACILLUS FERROOXIDANS.
Dispirito, Alan A.; Dugan, Patrick R.; Tuovinen, Olli H.
Ohio State Univ, Columbus, USA
Biotechnol Bioeng v 23 n 12 Dec 1981 p 2761-2769 CODEN: BIBIAU ISSN: 0006-3592

Particulate materials (flowers of sulfur, fluorapatite, glass beads, and pyrite) inhibited the growth of Thiobacillus ferrooxidans on ferrous iron at pH 1. 5. The inhibition caused by pyrite involved a soluble toxic component. The inhibition caused by sulfur particles and glass beads was alleviated by incubation under static culture conditions (i. e. , no shaking) but oxidation rates declined because of lack of aeration. An increase in the pH above 2 also relieved the inhibition. Thus, the results indicate that the bacterial activity at the liquid-solid interface is different from that in the bulk liquid phase and is influenced by the proton concentration and by the physicochemical properties of the solids in bacterial leaching systems. 16 refs.

1281692 EI8207081692

MATEMATICHESKOE MODELIROVANIE BIOGENNOI SUL'FATREDUKTSII V ZAVODNYAEMYKH KARBONATNYKH NEFTYANYKH KOLLEKTORAKH. $left bracket$ Mathematical Modeling of Biogenous Sulfate Reduction in Flooded Carbonate Petroleum Reservoirs $right bracket$.

Ametov, A. M.
Ukhta Ind Inst, Komi ASSR
Izv Vyssh Uchebn Zaved Neft Gaz n 7 Jul 1981 p 27-31
CODEN: IVUNA2 ISSN: 0445-0108

A mathematical model of the activity of biocenosis of hydrocarbon oxidizing and sulfate reducing bacteria in flooded carbonate petroleum reservoirs, which leads to hydrogen sulfide generation which makes the working of deposits difficult, is investigated. A method of suppressing the bacterial processes in the bottom hole zones of injection wells is proposed. It presupposes that no viable bacteria reach the stratum. In Russian.

1258035 EI8205038035

SULPHIDE OXIDIZING BACTERIA OF COPPER PORPHYRY ORE.

Hedgwick, John C.; Ralph, Bernard J.; Sadler, William R.
Univ of NSW, Kensington, Aust
Proc Australas Inst Min Metall n 279 Sep 1981 p 37-40
CODEN: AMMPAL ISSN: 0004-8364

Thiobacillus ferrooxidans catalyses biodegradation of chalcopyrite concentrates is shown. The process was growth associated at normal temperatures (30 $degree$ C) in dilute acid solution (pH2,H//2SO//4) in submerged cultures. There was a sequential development of bacteria in leachates from fresh ore irrigated with water only. High pH sulfur oxidizers were always present, low pH sulfur oxidizers appeared within a week while T. ferrooxidans took 50 days to show up. Routine monitoring of bacteria in dump leachates provided a qualitative indication of events in otherwise inaccessible ore bodies. 6 refs.

1234155 EI8201004155

BACTERIAL PYRITE OXIDATION: RELEASE OF IRON AND SCANNING ELECTRON MICROSCOPIC OBSERVATIONS.

Hiltunen, Paula; Vuorinen, Antti; Rohtijarvi, Pentti; Tuovinen, Olli H.
Univ of Helsinki, Finl
Hydrometallurgy v 7 n 1-2 Jun 1981 p 147-157 CODEN: HYDRDA
ISSN: 0304-386X

Dissolution from pyrite was enhanced by cultures of Thiobacillus ferrooxidans. Most of the iron in filtered leachates was in a fine-dispersed (colloidal) or chelated form. Scanning electron micrographs showed pitting of pyrite surfaces after 6 weeks leaching. 29 refs.

1178090 EI8109075090

BIOGEOCHEMISTRY OF ACID MINE DRAINAGE AND A METHOD TO CONTROL ACID FORMATION.

Kleinmann, R. L. P.; Crerar, D. A.; Pacelli, R. R.
US Bur of Mines, Pittsburgh, Pa
Min Eng (New York) v 33 n 3 Mar 1981 p 300-305 CODEN: MIENAB ISSN: 0026-5187

A bacterium, Thiobacillus ferroxidans, is of prime importance in the formation of acid drainage from pyritic material. Above pH 4. 5, T. ferrooxidans increases initial acidification; below pH 4. 5, it allows acidification to continue bY oxidizing Fe**2** $plus$. Below a pH of approximately 2. 5, the activity of Fe**3** $plus$ results in steady-state cycling between oxidation of pyrite by Fe**3** $plus$ and bacterial oxidation of Fe**2** $plus$. Tests demonstrate that inhibition of T. ferroxidans by controlled release of anionic detergents can inexpensively reduce pyrite oxidation and acid formation. 37 refs.

1090620 EI8012090620

GEOCHEMISTRY, SULFUR ISOTOPE COMPOSITION, AND ACCUMULATION RATES OF RED SEA GEOTHERMAL DEPOSITS.

Shanks, Wayne C. III; Bischoff, James L.
Univ of Wis, Madison
Econ Geol Bull Soc Econ Geol v 75 n 3 May 1980 p 445-459
CODEN: ECGLAL ISSN: 0013-0109

Geochemical studies of metalliferous sediments from the Atlantis II Deep reveal a varible history of hot brine activity. Radiocarbon dating indicates that sedimentation began in the deep about 28,000 yrs ago. The lowermost unit (DOP) consists mainly of detrital biogenic carbonates with occasional thin beds of iron oxide or sulfide minerals. Sulfur isotope composition and carbon-sulfur relations indicate that some of these sulfide layers have a hydrothermal source whereas others formed by bacterial sulfate reduction in the sediments. DOP zone sedimentation rates were about 25 cm/1000 yr. Continuous brine activity began in the lower sulfide zone (SU//1). Sulfur isotope values average 5. 4 (range 1 to 14) in this unit as in the upper sulfide (SU//2) and amorphous silicate (AM) zone. Organic carbon and sulfide sulfur values in the SU//2, SU//1, and AM zones indicate direct hydrothermal addition of sulfide. Refs.

1040247 EI800640247
REDOX SPECIES IN A REDUCING FJORD: EQUILIBRIUM AND KINETIC CONSIDERATIONS.
Emerson, S.; Cranston, R. E.; Liss, P. S.
Univ of Wash, Seattle
Deep Sea Res Pt A v 26 n 8A Aug 1979 p 859-878 CODEN: DRPPD8

In June 1977 ten redox sensitive chemical species were determined in the oxidizing and reducing waters of Saanich Inlet, British Columbia. An oxygen-hydrogen sulfide interface was found at a depth of 130 m. The concentrations of the oxidized species: oxygen, nitrate, iodate, and chromate, and the reduced constituents: hydrogen sulfide, ferrous iron, and ammonia reached background or near background levels at this depth. Three reduced constituents, manganese (II), chromium (III), and iodide existed metastably in the oxic layer. Thermodynamic calculations of pe indicate that the redox couples in the anoxic waters approach equilibrium with each other while those in the oxygenated waters are far from equilibrium. A time-dependent diffusion model is used to determine the removal rate constants for Mn**2** $plus$ and Cr(III) in the linear temperature-salinity region surrounding the oxygen-hydrogen sulfide interface (130 to 115 m). The rapid oxidation kinetics in Saanich Inlet are probably caused by bacterial catalysis near the oxygen-hydrogen sulfide interface. Refs.

1010767 EI800210767
FERRIC SULPHATE PERCOLATION LEACHING OF A PYRITIC Zn-Pb-Cu ORE.
Dutrizac, L. E.
Can Cent for Miner & Energy Technol, Ottawa, Ont
CIM Bull v 72 n 810 Oct 1979 p 109-118 CODEN: CIBUBA
ISSN: 0317-0926

In the experiments described here, a pyritic Zn-Pb-Cu ore from New Brunswick was subjected to percolation leaching using ferric sulfate-sulfuric acid solutions. Bacterial oxidation was employed in some tests to maintain a high Fe**3 $plus$ concentration, and these solutions were repeatedly recycled through the ore to build up a high dissolved zinc concentration. High zinc extractions were achieved after a few months leaching, and substantial zinc solution concentrations could be produced by recycle of the oxidized solution. 9 refs.

1007200 EI800107200
ENTFERNUNG VON SCHWERMETALLEN AUS KLAERSCHLAEMMEN DURCH BAKTERIELLE LAUGUNG. $left bracket$ **Removal of Heavy Metals from Sewage Sludges by Bacteriological Leaching** $right bracket$.
Schoenborn, Wolfgang; Hartmann, Helga
Gas Wasserfach Wasser Abwasser v 120 n 7 Jul 1979 p 329-335
CODEN: GWWAAQ ISSN: 0016-3651

Heavy metals in municipal sewage sludge constitute an ecological menace especially when the sludge is used in agriculture. A microbiological method is proprosed which is based on the known concept of bacterial leaching of low-grade pyritic ores. Investigations into the microbiological fundamentals of such a method have shown that Thiobacillus thiooxidans, which oxidizes reduced sulphur compounds, and T. ferrooxidans, which is distinguished by its ability to oxidize Fe II, can be used for solubilizing the mostly sulfide compounds contained in sewage sludge. The aerobic sludge treatment required for this at the same time probably serves as a liquid composting. The feasibility of introducing the proposed method into conventional sewage treatment operations is discussed. 14 refs. In German.

1005670 EI800105670
IZUCHENIE FLOTATSIONNYKH SVOISTV SUL'FATREDUTSIRUYUSHCHIKH BAKTERII PRI PERERABOTKE RUD. $left bracket$ **Study of the Flotation Properties of Sulfate-Reducing Bacteria During Ore Treatment** $right bracket$.
Solozhenkin, P. M.; Lyubavina, L. L.; Samokhvalova, L. F.; Pupkov, V. S.
Acad of Sci of Tadzh SSR, Inst of Chem
Izv Vyssh Uchebn Zaved Tsvetn Metall n 3 1979 p 13-21
CODEN: IVUTAK ISSN: 0021-3438

It is shown that sulfate-reducing bacteria are a more effective sulfidizer for oxidized minerals than sodium sulfide. Using the flotation of oxidized lead and copper-molybdenum ores with a bacterial culture as examples, the technical and economic feasibility of using these bacteria in the flotation of ores is confirmed. The great effectiveness of a cumulative bacterial culture as a sulfidizer and depressor is due to hydrolysis of hydrogen sulfide and the liberation of the hydrosulfide ion, which acts most effectively on the mineral surface. A cumulative bacterial culture is an active desorbent of xanthate from mineral surfaces. It is recommended that this culture be used as a selective reagent for separating collective sulfide concentrates, particularly lead-zinc and copper-molybdenum concentrates. 21 refs. In Russian.

931883 EI790531883
GALVANIC INTERACTION BETWEEN CHALCOPYRITE AND PYRITE DURING BACTERIAL LEACHING OF LOW-GRADE WASTE.
Berry, V. K.; Murr, L. E.; Hiskey, J. B.
NM Inst of Min & Technol, Socorro
Hydrometallurgy v 3 n 4 Oct 1978 p 309-326 CODEN: HYDRDA

When the pyrite and chalcopyrite were in contact, the resulting galvanic interaction caused the chalcopyrite to corrode more rapidly than the pyrite, which was effectively passivated. The leaching of chalcopyrite is thereby enhanced in contact with pyrite. This effect is accelerated in the presence of bacteria. The corrosion of chalcopyrite was also markedly enhanced as a result of the oxidation of elemental sulfur (formed during the reaction) to sulfuric acid. This reaction was also accelerated by bacterial catalysis. 20 refs.

845436 EI780645436
MICROBIOLOGY OF ANAEROBIC DEGRADATION AND METHANOGENESIS WITH SPECIAL REFERENCE TO SEWAGE.
Bryant, M. P.
Univ of Ill, Urbana
Microb Energy Convers, Proc of a Semin, Goettingen, Ger, Oct 1976 Publ by Pergamon Press, New York, NY, 1977 p 107-117

The anaerobic degradation of organic matter to CO//2 and CH//4 as it occurs in sewage involves a consortium of interacting anaerobic microbes. The process includes three general groups of bacteria. The first group is a complex of fermentative species which hydrolyze the primary substrates such as cellulosic materials, lipids and proteins and ferment the products to acetic and other organic acids, alcohol, H//2, CO//2, NH//3 and sulfide. The second group of bacteria, as yet mainly hypothetical, oxidizes the acids with longer carbon chains than acetate and alcohol with production of more acetate and the electrons generated are probably excreted as H//2. The third group involves diverse species of methanogenic bacteria which utilizes the H//2 and CO//2 and acetate for growth and production of the final products, CH//4 and CO//2. The fermentative group excretes products which are needed as energy and nutrient sources by the other two groups. Refs.

844048 EI780644048
EXTRACTION OF METALS FROM ORES BY BACTERIAL LEACHING: PRESENT STATUS AND FUTURE PROSPECTS.
Kelly, D. P.
Univ of Warwick, Coventry, Engl
Microb Energy Convers, Proc of a Semin, Goettingen, Ger, Oct 1976 Publ by Pergamon Press, New York, NY, 1977 p 329-338

The principle organism effecting bacterial leaching of ferrous and sulphide ores is Thiobacillus ferrooxidans, though other thiobacilli and other bacteria may be involved. The process depends on (a) direct solubilization of metal sulphides by bacterial oxidation; (b) dissolution of metal

pyrite oxidation. Mining spoil dumps and low grade ores can be leached for copper or uranium by cheap low-level technology. Dump leaching enables maximum recovery of valuable metal from any ore, but makes possible exploitation of very low grade Cu and U ores. Continuous extraction processes are possible where a continuously growing bacteria culture is fed with pyritic ores (or FeSO//4 or other sulphide) and continuous metal solubilization proceeds. Two-stage leaching systems present the best prospect for developing a higher-level technology for metal extraction. Two-stage processes can be surface processes using crushed or milled ores or can be applied to underground solution mining, when an ore (e. g. uranium) can be leached by (e. g. solvent extraction) and Fe**3** $plus$ regenerated by bacterial oxidation at the surface. The use of controlledcontinuous microbial cultures to generate either bacteria or ferric iron is outlined. Refs.

780257 EI771180257
DIRECT OBSERVATIONS OF SELECTIVE ATTACHMENT OF BACTERIA ON LOW-GRADE SULFIDE ORES AND OTHER MINERAL SURFACES.
Murr, L. E.; Berry, V. K.
NM Inst of Min & Technol, Socorro
Hydrometallurgy v 2 n 1 Jul 1976p 1-10 p 11-24 CODEN: HYDRDA

The selective attachment of a thermophilic, pleomorphic autotroph to the pyritic (FeS//2) or chalcopyrite (CuFeS//2) phases of a low grade copper ore was observed using a scanning electron microscope. The selective attachment was further confirmed by the identification of ore mineral phases by elemental x-ray mapping in conjunction with an energy-dispersive analyzer. These observations provide strong support for the direct contact mechanism of bacterial oxidation of minerals, particularly sulfide minerals during leaching. Preferential attachment of microorganisms to specific areas on turquoize was also observed. The bacteria were observed to attach adsorptively to the phase surface and the attachment seems to be quite tenacious. Some possible indication of the production of biomatter surrounding the attachment zone of microorganisms on turquoise was also observed. The thermophilic bacteria in some instances were observed to form a continuous layer of the microbes on pyrite phases. 24 refs.

762895 EI770062895

SULPHUR ISOTOPE COMPOSITIONS OF SULPHIDES AND SULPHATES, DSDP LEG 37.

Krouse, H. R.; Brown, H. M.; Farquharson, R. B.

Univ of Calgary, Alberta

Can J Earth Sci v 14 n 4 pt 2 Apr 1977 p 787-793 CODEN: CJESAP

Sulphur isotope abundances are determined for 15 sedimentary and 9 basalt specimens from DSDP Leg 37 cores. Sedimentary sulphides had $delta$ **3**4S values on low as $minus$ 54%, which is consistent with isotopic selectivity during bacterial sulphate reduction. The $delta$ **3**4S values for soluble sedimentary sulphates are generally lower than ocean water sulphate. This is probably due to contributions of oxidized sedimentary sulphides. Pyrite in basalt fractures have $delta$ **3**4S values ranging from $minus$ 33% to $minus$ 9%. An unique interpretation of these data is not possible at this time. 14 refs.

761263 EI770061263

SULFATE REDUCTION AND SULFUR DEPOSITION IN THE LOWER FARS FORMATION, NORTHERN IRAQ.

Al-Sawaf, F. D. S.

Univ Coll, London, Engl

Econ Geol Bull Soc Econ Geol v 72 n 4 Jun-Jul 1977 p 608-618 CODEN: ECGLAL

The study of the quality, temperature, and gas content of ground water and of the distribution of sulfate-reducing bacteria in the Lower Fars Formation of northern Iraq shows that minable sulfur deposits result from sulfate reduction and hydrocarbon oxidation in the presence of the sulfate-reducing bacteria Desulfovibrio desulfuricans. The richest sulfur ore was deposited in anticlinal structures containing an ample supply of hydrocarbon gases and a continuous supply of sulfate ions from the soluble gypsum and anhydrite in the Lower Fars Formation. In these anticlines, a continuous flow of ground water takes place in an open hydrologic system (water-table aquifer). The hydrogen sulfide which evolves and migrates from the lower parts of the structure is oxidized by oxygen in the ground water. 10 refs.

718334 EI770318334

EFFECT OF HEAVY METAL IONS ON THE ACTIVITY OF AN IRON-OXIDIZING CHEMOAUTOTROPH.

Imai, Kazutami

Okayama Univ, Jpn

Proc of the Jt MMIJ (Min and Metall Inst of Jpn) $EM DASH$ AIME Meet: World Min and Met Technol, Denver, Colo, Sep 1-3 1976 Publ by AIME, New York, NY, 1976 v 1 p 321-332

Since iron-oxidizing chemoautotrophic bacteria can assist in acid leaching of metals from sulfide ores, it is important to investigate the adverse effects of metal ions on the growth and iron-oxidizing activity of the bacteria. This paper deals with screening of harmful metal ions and with their inhibiting mechanism affecting the activity of Thiobacillus ferrooxidans. 11 refs.

707779 EI770207779
EUROPEAN BREWERY CONVENTION, PROCEEDINGS OF THE CONGRESS, 15TH, 1975.
Anon
Eur Brew Conv, Rotterdam, Neth
Eur Brew Conv, Proc of the Congr, 15th, Nice, Fr, 1975 Publ by Elsevier Sci Publ Co, New York, NY, 1975 850 p

Sixty-two papers by various authors deal with beer making and related processes. Major topics covered are barley development in the European Economic Community, spray-steeping and immersion steeping; storage of cured malts; influence of the quality of barley and malt on the composition of wort and beer; brewing behavior of malt; economic and technical aspects of fuels for the kilning of malt; malt quality and beer aroma; contribution of hop-derived compounds to beer aroma; improvements of hop aroma in beer; transformation of lupulone into beer-soluble bitter substances; hops liaison committee report; synthetic-hop bitter substances for beer production; economics of using isomerized hop extract; protein degradation during mashing; kinetic and energetic studies of mashing; materials and methods of wort production that influence beer filtration; aspects of beer filtration; high temperatures for shortening wort boiling; control of volatile acetate ester concentration in beer by using oxygenation during fermentation; fermentation of high gravity worts; noise abatement in a brewery; pollution of brewery effluents; servo control of bottling lines; new fermentation and layering processes; recycling of spent grain press liquor; effect of killer factors on brewing yeasts; effects of killer yeasts in mixed batch and continuous cultures in wort; detection of wild yeast contaminants; characterization of a mutant of saccharomyces carlsbergenesis; ethanol tolerance of brewing yeasts; evolution of oxido-reductance of barley during germination; action of papain on beer proteins during pasturization; model experiments illustrating some aspects of the mechanism of chill haze formation; foam properties of beer studied by tensiolaminometry; glycoproteins and beer foam; wort composition; advances in microbiological quality control; report on the activities of the microbiology group; analysis of wort bacteria types; rapid fermentation and maturation; effect of pH and agitation on beer fermentation; formation of higher aliphatic alcohols in relation to substrate utilization by the yeast; nitrate and nitrite in brewery fermentation; technological measures to control the formation of esters during beer fermentation; effect of chelators in brewery fermentation; effect of fermentation temperature and pressure on yeast metabolism and beer quality; economic aspect of present-day brewing; effect of raw material and production conditions on the filterability of beer; free fatty acids in wort and beer; changes in the free fatty acids and other lipids of worts during boiling and fermentation; debranching enzymes in brewing; formation of carbonyl compounds and changes in beer flavor; dimethyl sulfide development in malting, brewing and fermentation; formation of phenols and oxygen-containing heterocyclic compounds in beer; electrochemical-potentiostatic measuring device for continuous measurement of oxygen in wort and beer; group analysis and gas chromatographic analysis of beer constituents; report of the analysis committee; the EBC thesaurus for the brewing industry; development of a flavor library; and report of the chairman of the Barley Committee.

674837 EI761174837
CARBON AND SULFUR ISOTOPE ABUNDANCES IN ARCHEAN IRON-FORMATIONS AND EARLY PRECAMBRIAN LIFE.
Goodwin, A. M.; Monster, J.; Thode, H. G.
Univ of Toronto, Ont
Econ Geol Bull Soc Econ Geol v 71 n 5 Aug 1976 p 870-891
CODEN: ECGLAL

The volcanically enclosed Michipicoten and Woman River iron-formations, both approximately 2. 75 b. y. old, in Superior Province of the Canadian Shield lie at lithologically similar stratigraphic contacts between underlying felsic pyroclastics and overlying mafic lava flows. both iron-formations display similar lateral transitions of, from west to east, oxide, carbonate, and sulfide facies, a common facies pattern attributed to chemical deposition of volcanically derived components upon eastward-inclined slopes forming parts of local volcano-tectonic basins of deposition. Both iron-formations contain numerous, thin graphitic units. The sulfur and carbon isotope data provide strong evidence for the existence of autotrophic organisms and reducing bacteria in Archean times, but taken together with geological considerations as to the physical and chemical environment of deposition, the evidence appears overwhelming. Refs.

DIALOG INFORMATION SERVICES, INC.

637226 EI760637226
MODEL OF THE DUMP LEACHING PROCESS THAT INCORPORATES OXYGEN BALANCE, HEAT BALANCE, AND AIR CONVECTION.
Cathles, L. M.; Apps, J. A.
Kennecott Copper Corp, Lexington, Mass
Metall Trans B v 6B n 4 Dec 1975 p 617-624 CODEN: MTTBCR
A one dimensional, nonsteady-state model of the copper waste dump leaching process has been developed which incorporates both chemistry and physics. The model is based upon three equations relating oxygen balance, heat balance, and air convection. It assumes that the dump is composed of an aggregate of rock particles containing nonsulfide copper minerals and the sulfides, chalcopyrite and pyrite. Leaching occurs through chemical and diffusion controlled processes in which pyrite and chalcopyrite are oxidized by ferric ions in the lixiviant. Oxygen, the primary oxidant, is transported into the dump by means of air convection and oxidizes ferrous ion through bacterial catalysis. The heat generated by the oxidation of the sulfides promotes air convection. The model was used to simulate the leaching of copper from a small test dump, and excellent agreement with field measurements was obtained. The model predicts that the most important variables affecting copper recovery from the test dump are dump height, pyrite concentration, copper grade, and lixiviant application rate. 13 refs.

634434 EI760634434
ODOR CONTROL AT HERSHEY WASTEWATER RECLAMATION PLANT USING HYDROGEN PEROXIDE TREATMENT.
Cole, Charles A.; Paul, Paul E.; Brewer, Harold P.
Pa State Univ, Middletown
Mid-Atl Ind Waste Conf, 7th, Proc, Philadelphia, Pa, Nov 12-14 1974 p 134-160. Publ by Drexel Univ, Philadelphia, Pa, 1975
Hershey wastewater plant treats approximately 2 mgd (7580 cu m/day) of domestic and industrial waste. Investigation of the odor cause showed that the odors were coming predominately from the flotator-clarifier and intermediate clarifier effluents and were due to conditions associated with H//2S formation. H//2O//2 acts through mechanisms of oxidant action, oxygen production and bacteriacidal action to prevent sulfide formation. The effectiveness was demonstrated in two winter tests followed by continuous use starting in the early summer. H//2O//2 dose of from 15 to 40 mg/l were found necessary to control the odors at the plant. The cost of treatment was from $56. 00 to $106. 00 per mgd.

608541 EI760208541
USING OXYGEN TO REACTIVATE A NEARLY DORMANT COPPER SULFIDE LEACH.
Madsen, B. W.; Groves, R. D.
Salt Lake City Metall Res Cent, Utah
US Bur Mines Rep Invest n 8056 1975, 13 p CODEN: XBMIA6
A nearly dormant copper sulfide pilot-scale experimental leach containing 8. 7 tons of ore was injected with oxygen to determine its effect on the copper-leaching rate. Prior treatment of the uncrushed 0. 25-percent-copper, mine-run stripping material consisted of 461 days of acid ferric sulfate leaching, which extracted 47 percent of the total copper. The permeability of the bed had decreased, and the percolation rate had decreased from an initial 20 gallons to 0. 8 gallons per square foot per day. Copper extraction had nearly stopped. After injecting oxygen into the ore column and leaching for 30 days, the percolation rate was increased to 6 gallons per square foot per day. In an additional 298 days of leaching, an additional 40. 7 percent of the copper was extracted. The improved leaching after the use of oxygen is attributed to stimulated bacterial action, better oxidation, and increased permeability.

585126 EI751285126
UPWARD MIGRATION OF DEEP-WELL WASTE INJECTION FLUIDS IN FLORIDAN AQUIFER, SOUTH FLORIDA.
Kaufman, M. I.; McKenzie, D. J.
J Res US Geol Surv v 3 n 3 May-Jun 1975 p 261-271 CODEN: JRGSAW
Geochemical data from an industrial deep-well waste injection system southeast of Lake Okeechubee indicate a decrease in sulfate concentration concomitant with an increase in hydrogen sulfide concentration, a result of oxidation of injected organic waste by anaerobic bacteria. Subtle decreases in the sulfate-chloride ratio suggest that the waste migrated upward to a shallow monitor well about 27 mo after waste injection began and again within 15 mo of resumption of waste injection after the injection well was deepened. Graphs, equations and tables show data. 13 refs.

567124 EI751067124
BACTERIAL OXIDATION OF PYRITE.
Le Roux, N. W.; North, A. A.; Wilson, J. C.
Warren Spring Lab, Stevenage, Herts, Engl
Int Miner Process Congr, 10th, Proc, London, Engl, Apr 2-6 1973 p 1051-1066. Publ by Inst of Min and Metall, London, Engl, 1974

The leaching of ores by processing depending on the action of Thiobacillus ferrooxidans is now a well-established practice, and in almost every case the bacterially assisted oxidation of pyrite is of importance. Studies of this topic have extended over several years and data are presented from investigations which used the shake-flask technique and also prolonged continuous operation of a pilot-scale leaching vessel of capacity 84 l. Rates of oxidation of pyrite at 30 $degree$ C are given with respect to variables, such as pulp density, method of agitation, pH, concentration of ferric iron and nutrients and bacterial activity. Methods of determining bacterial numbers in the reactor are described and some conclusions are given on the distribution of bacteria between those free in the liquid phase and those attached to solids. Some shortcomings in the methods used to count the bacteria are discussed. Limited comparisons are made with results based on microscopic bacterial cell counts and bacterial activity as indicated by respirometer measurements of the rate of oxygen uptake. 10 refs.

470950 EI741170950
SELECTIVE BACTERIAL LEACHING OF A LEAD SULPHIDE CONCENTRATE.
Torma, A. E.; Subramanian, K. N.
Min Res Cent, Que
Int J Miner Process v 1 n 2 May 1974 p 125-134 CODEN: IJMPBL

Leaching with Thiobacillus ferooxidans has been used for selectively extracting Cu, Zn and Cd values from a PbS concentrate. The PbS is partly oxidized to the sulphate form. A scheme has been proposed for the recovery of the metal values from the leach liquor. 34 refs.

448718 EI740848718
DEVELOPMENT OF A BIOCHEMICAL DESULFURIZATION PROCEDURE FOR FUELS.
Davis, A. J. III; Yen, T. F.
Univ of South Calif, University Park, Los Angeles
Am Chem Soc, Div Fuel Chem, Prepr v 19 n 2, 1974, for Meet, Los Angeles, Calif, Apr 1-5 1974, p 218-223 CODEN: ACFPAI

Results of an experimental study are presented which was intended to explore the ability of a microorganism as a possible desulfurizing agent. To this end, a pure system was employed that would give us some idea as to the ease with which such an agent could abstract organically-bound sulfur. While this program is preliminary in scope, it is hoped that future investigations may lead to a feasible industrial application. The strain of Thiobacillus thiooxidans used in these experiments was originally obtained from the National Tyope Cultures Collection. Onoculate strain was obtained by further culture in the authors' laboratory. It is shown that the sulfur of the sulfide samples investigated was susceptible to bacterial attack in two of the three cases. The aliphatic sulfides could be ranked in the order of their ease of oxidation as: di-t-butyl polysulfide $greater than$ di-t-butyl disulfide $greater than$ di-ti-butyl sulfide. Mechamisms of bacteria-caused degradation of sulfur compounds in petroleum are suggested. 6 refs.

405846 EI740205846
BACTERIAL OXIDATION IN UPGRADING PYRITIC COALS.
Capes, C. E.; McIlhinney, A. E.; Sirianni, A. F.; Puddington, I. E.
Nat Res Counc of Can, Ottawa, Ont
Can Min Metall Bull v 66 n 739 Nov 1973 p 88-91 CODEN: CMMBAZ

Two main problems are associated with the removal of pyritic sulfur from coals. The first is due to the fine state of dissemination of pyrite, which requires grinding to a very fine size to accomplish liberation. The second problem is caused by the similar surface chemical characteristics of coal and pyrite, which complicates separation methods based on this property. In the work described here, the problem of fine particle size was overcome by using the selective oil agglomeration method developed at the National research Council of Canada. Recovery of more than 90% of the combustible values was possible, even with particles only a few microns in diameter. Experiments using conventional chemical depressants for pyrite met with little success. It was found, however, that pyrite may be rejected during coal agglomeration through treatment with the iron-oxidizing bacteria, thiobacillus-ferrooxidans. The conditions for maximum pyrite separation are described and possible mechanisms by which the bacteria act are discussed. 20 refs.

326136 EI730828136

HEAP LEACHING TESTS ON GASPE COPPER OXIDE ORE.

Jennings, P. H.; Tarassoff, P.; Ford, R. E.

Noranda Res Cent, Pointe Claire, Que

Trans Soc Mining Eng AIME v 254 n 1 Mar 1973 p 80-88 CODEN: TAMMAZ

Copper oxide ore may be leached at all sizes from run-of-mine down to pulp, and consideration must be given to all available methods in determining the most economical one. Heap leaching was evaluated in a pilot plant at Gaspe Copper Mines, Ltd. which was designed to simultaneously leach two 1200-ton dumps of ore. The plant was operated for two years, in part under severe winter conditions. Two modes of leaching were investigated: acid leaching in which sulfuric acid was added externally to the leach solution, and pyritic leaching in which pyrite concentrate was added to the dump and acid was generated in situ by bacterial action. The pilot plant operation is described, and the results are compared with laboratory data obtained in 6-in. -diam columns. It is concluded that pyritic leaching offers certain operating advantages over acid leaching when copper is recovered by cementation in that iron buildup in the solution is prevented. 6 refs.

305195 EI730105195

MICROBIOLOGICAL ASPECTS IN THE LEACHING OF URANIUM BY THIOBACILLUS FERROOXIDANS.

Tuovinen, O. H.

Queen Elizabeth Coll, London, Engl

At Energy Rev v 10 n 2 1972 p 251-258

The microbiological aspects involved in the leaching of uranium by iron oxidizing bacteria are discussed. The following problems are emphasized: toxicity of soluble uranium and organic solvents to Thiobacillus ferrooxidans, and the loss of cells at various stages of the leaching process. Hydrolysis of ferric ion in relation to the acidity and the advantage of the use of pyrite are described. Distinction is made between natural leaching by heterogenous Thiobacillus populations and laboratory studies with pure cultures. 55 refs.

298576 EI721320579

JOINT MEETING MMIJ-AIME, 1972, TOKYO.

Jacobson, R. H. Jr.; McKee, Chester R.; Roman, Ronald J.; Brierley, James A.; Bhappu, Roshan B.; Imai, K.; Sugio, Tsuyoshi; Yasuhara, Teruo; Tano, Tatsuo; Kataoka, S.; Yamada, S.; Glasser, J.; Okubo, Y.; Allen, E. S.; Kruesi, P. R.

Joint Meeting MMIJ-AIME, Tokyo, Jap, May 24-27 1972 Min and Metall Inst of Japan, Tokyo, 1972, 5 Volumes, G, T-I, T-II, T-III, T-IV, various pagings

Following is part 12 of the list of titles and authors. Optimization of Dump and Heap Leaching $EM DASH$ Theoretical and Practical Studies. By R. H. Jacobson, Jr. Iron Oxidation by Bacteria. By K. Imai. Beneficiation of Ilmenite Ore By Ishihara Process. By S. Kataoka and S. Yamada. Potential Extractive Processes for Titanium Scrap Reclamation. By J. Glasser. Treatment of Pyrite Cinders at Dowa Seiko, Amagasaki Plant. By Y. Okubo. Cymet Electrometallurgical Processes for Treating Base Metal Sulfide Concentrates. By E. S. Allen and P. R. Kruesi.

286201 EI721108202

THERMODYNAMIC AND KINETIC FACTORS IN THE LEACHING OF SULPHIDE MINERALS FROM ORE DEPOSITS AND DUMPS.

Peters, E.

Univ of British Columbia, Vancouver

Soc Min Eng of AIME, SME Short Course (Bio Extractive Mining), Denver, Colo, Feb 1970. SME, 1970. p 46-75

Paper discusses title phenomena and concludes that the oxidation or reduction of sulphur through the sulphate state is very irreversible under electrochemical conditions. This is the reaction in which bacteria play their greatest role. The importance of this reaction is in generating sulphuric acid to keep mine waters at a low enough pH to permit solubilization of metal. It is possible that the increased use of manufactured acid as additions to extraction mine waters may suppress the role of the bacteria in the leaching process. 5 refs.

286200 EI721108201

BIOEXTRACTIVE MINING.

Malouf, E. E.

Kennecott Copper Corp, Salt Lake City, Utah

Soc Min Eng of AIME, SME Short Course (Bio Extractive Mining), Denver, Colo, Feb 1970. SME, 1970, p 1-45

Paper discusses the broad range of sulfide-minerals transformation by bacterial action, analyzes effect of specific groups of bacteria, and indicates resistance of sulfide minerals to the oxidation within the range from lowest (pyrrhotite) to highest (molybdenite). Current applications of bioextractive mining are described. 297 refs.

283551 EI721105551
BACTERIAL LEACHING: AN INTRODUCTION TO ITS APPLICATION AND THEORY AND A STUDY ON ITS MECHANISM OF OPERATION.
Corrans,I. J.; Harris, B.; Ralph, B. J.
JCI Minerals Processing Lab, New South Wales, Aust
J S Afr Inst Min Metall v 72 n 8 Mar 1972 p 221-230
In the first section a brief background to the practical and theoretical aspects of bacterial leaching is presented. Descriptions are given of present and potential methods for exploring bacterial leaching in metalwinning. In the second section, the results of recent research are presented. The aim of this work was to obtain a greater understanding of the mechanism of bacterial leaching of sulfide minerals. Bacteria were observed to catalyze leaching reactions by oxidizing ferrous ions to ferric ions, by removing protective films at the mineral surface and by depolarizing cathodic areas. 28 refs.

241486 EI72X041486
Bacterial leaching of cadmium sulphide
BRISSETTE C; CHAMPAGNE J; JUTRAS JR
Ecole Polytechnique, Montreal, Que
Can Mining Met Bull v 64 n 714 Oct 1971 p 85-8 CODEN: CMMBA
Pure cadmium sulfide was leached by the action of the bacterium Thiobacillus thiooxidans in the presence of finely divided sulfur. The influence of time, temperature, pH and concentration of inoculum on the extent of the cadmium extraction was studied. Under optimum conditions, up to 72% of the cadmium could be dissolved over a six- week period. A cursory study of the role played by elemental sulfur seems to indicate that its presence is essential but that the sulfuric acid produced through its oxidation is a minor factor in the cadmium extraction. 13 refs.

224797 EI72X024797
Enhancing bacterial activity in uranium mine
DUNCAN DW; BRUYNESTEYN A
Mineral Microbiology Section, Vancouver, B C
Can Mining Met Bull v 64 n 709 May 1971 p 32-6 CODEN: CMMBA
Acidic mine waters containing solubilized uranium have been observed in many uranium and some copper mines. In every case, the sulfide and iron oxidizing bacterium, Thiobacillus ferrooxidans, was also present. This bacterium provides the ferric iron required to oxidize UU4, both by oxidizing available ferrous iron and by oxidizeing pyrite or other available sulfide minerals. This latter oxidation also provides sulfuric acid and may increase extraction by exposing more uranium. The enhancement of bacterial activity and the results of some field tests are discussed. 22 refs.

166806 EI71X166806

Sulfidmineralien)
HAEASHI F
Anaconda Co, Tucson, Ariz
Metall v 24 n 10 Oct 1970 p 1074-82 CODEN: MTLLA
This state of the art survey deals with theory and applications. Methods of leaching metal sulfide ores are divided into those used in the absence and presence of oxidizing substances, respectively. Methods using bacteria are also discussed. 45 refs. In German.

133640 EI71X033640
Black shale heaving at Ottawa, Canada
QUIGLEY RM; VOGAN RW
Univ of Western Ontario, London
Can Geotech J v 7 n 2 May 1970 p 106-112 CODEN: CGJOA
Three in. (7. 6 cm) of differential heave has caused severe structural deformation of a lightly loaded building founded directly on drained black shale bedrock. Portions of the building founded on shale below the water table have not heaved. The heave is attributed to oxidation of disseminated iron sulfide in shale by autotrophic bacteria to produce secondary hydrous sulfates of greater volume. Auto trophic bacterioa of the Ferrobacillus and Thiobacillus ferroxidan types were confirmed by laboratory cultures to exist in the rock waters. The potential importance of heave and sulfate attack on future underground concrete structures in areas of Ottawa underlain by black shale is discussed.

H

APPENDIX H

ENVIRONMENT ABSTRACTS (ENVIROLINE) DATABASE

SEARCH #1 OF 1

SEARCH STRATEGY:

[ACID AND MINE DRAINAGE]

AND

[PYRIT? OR SULPHIDE OR SULFIDE]

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  168016    *83-006676
  STUDY  OF  ACID MINE DRAINAGE IN NORTH EASTERN COAL MINES OF
INDIA ,
  RAWAT,   NARENDRA S. ; SINGH  GURDEEP
  INDIAN SCHOOL OF MINES, INDIA
  PRESENTED AT INTL MINE WATER ASSN 1ST CONF,  BUDAPEST,   APR
19-24, 82, P133 (16)
  THE NATURE OF MINE DRAINAGE IN THE NORTH EASTERN COAL FIELD,
ASSAM, INDIA,  IS DISCUSSED.   THIS DRAINAGE HAS BEEN FOUND TO
HAVE SULFATE  CONCENTRATIONS  OF  UP  TO  1500  PPM  AND  IRON
CONCENTRATIONS TO 40 PPM.   THE ACIDITY OF THE MINE DRAINAGE IS
A  RESULT  OF  THE  OXIDATION  AND  DECOMPOSITION  OF REACTIVE
PYRITES IN THE COAL WASTES.   THE ORGANIC SULFUR IN THE WASTES
HAS  BEEN  FOUND  TO  BE  CHEMICALLY  INERT.   (7  PHOTOS,  14
REFERENCES, 4 TABLES)


  167999    *83-006659
  ESTIMATING THE MINIMUM ACID LOAD THAT CAN BE EXPECTED FROM A
COAL STRIP MINE .
  CARUCCIO,   FRANK T. ; GEIDEL  GWENDELYN
  UNIV OF SOUTH CAROLINA
  PRESENTED  AT UNIV KENTUCKY/ET AL SURFACE MINING HYDROLOGY &
RECLAMATION SYM, LEXINGTON, KY, DEC 7-11, 81, P117 (6)
  A TECHNIQUE FOR DETERMINING THE MINIMUM ACID LOAD  THAT  CAN
BE  EXPECTED  FROM  A COAL STRIP MINE IS DESCRIBED.  SIMULATED
WEATHERING TESTS ARE USED TO ASSESS  THE  CHEMICAL  WEATHERING
ATTRIBUTES OF STRATA COLLECTED FROM CORES OF OVERBURDEN.   FOR
A GIVEN  TIME  PERIOD,   THE  AMOUNT  OF  ACIDITY  POTENTIALLY
PRODUCED   BY   A  PARTICULAR  SAMPLE  CAN  BE  OBTAINED  FROM
CUMULATIVE ACID PLOTS. BY DEFINING A UNIT COLUMN OF OVERBURDEN
THICKNESS AND ASSUMING THAT AT LEAST 1% OF THE ROCK PHYSICALLY
DECOMPOSES TO THE SIZE FRACTION USED IN THE WEATHERING  TESTS,
A  QUANTITATIVE  ESTIMATE OF THE MINIMUM ACID LOAD PRODUCED BY
THE ROCK SEQUENCE FOR VARIOUS TIME PERIODS CAN BE  MADE.   (10
REFERENCES)


  167972    83-006632
  BIOLOGICAL TREATMENT OF ACID MINE DRAINAGE .
  HERRICKS EDWIN E.
  UNIV OF ILLINOIS WATER RESOURCES CENTER REPORT 173,  OCT 82,
(87)
  RESEARCH  WAS  CONDUCTED  TO  EVALUATE  METHODS  FOR  THE
BIOLOGICAL TREATMENT OF ACID MINE DRAINAGE (AMD).  TWO GENERAL
APPROACHES WERE EVALUATED.  THE FIRST EVALUATED  TREATMENT  OF
IMPOUNDED  AND  THROUGH  THE  ADDITION  OF  A  MIXED MICROBIAL
COMMUNITY   AND   CARBON   SOURCES   APPROPRIATE   FOR   THEIR
MAINTENANCE.   A SECOND EFFORT WAS DIRECTED TO EVALUATION OF A
BIOLOGICALLY  BASED  UNIT  PROCESS  FOR  AMD  TREATMENT.   AN
ANAEROBIC  DIGESTOR  PROVIDED  WASTE  LIQUORS  HIGH IN ORGANIC
ACIDS AND AMD WAS MIXED WITH DIGESTOR EFFLUENT IN AN ANAEROBIC
REACTOR TO  MAINTAIN  SULFATE  REDUCTION.   (NUMEROUS  GRAPHS,
TABLES)
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  167527    *83-006187
  PREVENTION OF ACID DRAINAGE FROM STORED COAL ,
  OLEM,   HARVEY  ; BELL  TRACEY L.; LONGAKER JEFFREY J.
  TVA,
  J ENERGY DIV-ASCE, JUN 83, V109, N2, P103 (10)
  LARGE QUANTITIES OF COAL ARE GENERALLY STORED ON THE GROUND,
WHICH  EXPOSES  THEM  TO  THE ELEMENTS AND THUS ALLOWS PYRITIC
MATERIALS IN THE COAL TO COMBINE WITH BACTERIA AND LEACH  ACID
DRAINAGE  INTO  THE  SOIL.   A  METHOD HAS BEEN DEVELOPED FOR
CONTROLLING SUCH DRAINAGE AND SUBSEQUENT DISSOLUTION OF  TOXIC
POLLUTANTS.   THE  METHOD ATTEMPTS TO PREVENT ACID DRAINAGE BY
APPLYING AN ENVIRONMENTALLY SAFE DETERGENT FORMULATION TO  THE
COAL. (1 DIAGRAM, 1 GRAPH, 10 REFERENCES, 4 TABLES)


  166759    *83-005468
  Control of Acid Mine Drainage Using Anionic Surfactants,
  Kleinmann,   Robert L. ; Erickson  Patricia M.
  USBM, PA
  presented  at Intl Mine Water Assn 1st Conf,  Budapest,  Apr
19-24, 82, p51 (14)
  A practical method of bacterial inhibition of the  oxidation
of  pyrite  that  has  reduced  acid  formation  is discussed.
Oxidation of pyrite plays a major role  in  the  formation  of
acid mine water,  which pollutes thousands of miles of streams
in the eastern U.S. each year.   Certain biodegradable anionic
surfactants,  such as sodium lauryl sulfate,  kill acidophilic
iron-oxidizing bacteria in pyrite at concentrations of 25 mg/l
or more;  use of these surfactants lowers titratable acidities
by 75% from normal levels. (8 graphs, 29 references)


  163047    83-001877
  EVALUATION  OF  ACID  PRODUCTION  POTENTIAL  OF MINING WASTE
MATERIALS,
  BRUYNESTEYN,  A. ; HACKL R. P.
  BC RESEARCH, CANADA,
  MINERALS & ENV, MAR 82, V4, P5 (4)
  TECHNICAL REPORT:  THE CHEMISTRY  OF  BIOLOGICALLY  ASSISTED
ACID PRODUCTION IS DETAILED,  AND METHODS CREATED TO DETERMINE
WHETHER OR NOT A MINING WASTE MATERIAL HAS THE  CAPABILITY  TO
BECOME  ACID PRODUCING WHEN LEFT EXPOSED TO THE ATMOSPHERE ARE
PRESENTED.  SCALE-UP TESTING CAN SIMULATE THE  CHARACTERISTICS
OF  EFFLUENTS  PRODUCED  FROM  A  COMMERCIAL-SIZE  WASTE DUMP.
LOCALIZED BIOLOGICAL ACTIVITY MAY OCCUR IN MOIST  AREAS  OF  A
WASTE DUMP DURING PERIODS OF LITTLE OR NO RAINFALL,  RESULTING
IN THE ACCUMULATION OF SOLUBLE  POLLUTANTS.   (2  GRAPHS,   14
REFERENCES, 2 TABLES)
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163801 *83-001356

ACID MINE DRAINAGE: CONTROL AND ABATEMENT RESEARCH,

KIM, ANN G. ; HEISEY BERNICE S.; KLEINMANN ROBERT L.; DEUL MAURICE

USBM PITTSBURGH RESEARCH CENTER,

USBM REPORT IC8905, 1982 (22)

SPECIAL REPORT: ACID DRAINAGE FROM UNDERGROUND COAL MINES AND COAL REFUSE PILES IS ONE OF THE MOST PERSISTENT INDUSTRIAL POLLUTION PROBLEMS IN THE U.S. CONTROL AND ABATEMENT RESEARCH BEING CONDUCTED BY USBM IS REVIEWED. ACID DRAINAGE FORMATION CHEMISTRY IS DESCRIBED. MINE SEALING TREATMENTS ARE BEING DEVELOPED TO HELP REDUCE ACID PRODUCTION. CHEMICAL NEUTRALIZATION TREATMENT PROCESSES ARE ALSO BEING CONSIDERED TO DECONTAMINATE DRAINAGE EFFLUENTS. SOURCE CONTROL TECHNOLOGY IS DISCUSSED. (5 DIAGRAMS, 10 GRAPHS, 1 PHOTO, 38 REFERENCES, 3 TABLES)

154955 *82-000625

EVALUATION OF CHEMICAL AGENTS FOR INHIBITING ACID MINE DRAINAGE FORMATION,

NEBGEN, JOHN W. ; WEATHERMAN DOUGLAS F.

MIDWEST RESEARCH INST, KANSAS CITY,

NTIS REPORT PB80-176357, APR 79 (128)

SPECIAL REPORT: A USBM STUDY ON THE INHIBITION OF ACID MINE DRAINAGE FORMATION FROM UNDERGROUND COAL MINES IS PRESENTED, WITH DATA FROM EXPERIMENTS ON THREE PYRITIC MATERIALS EVALUATED USING SEVERAL CANDIDATE INHIBITING AGENTS. THESE DATA ARE COMPARED WITH DATA FROM EXPERIMENTS THAT USE UNTREATED PYRITIC WASTES. ACID MINE DRAINAGE CAN BE REDUCED WHEN SOLUBLE IRON III IS CONTROLLED.

153320 *81-006138

INHIBITION OF ACID MINE DRAINAGE FORMATION: THE ROLE OF INSOLUBLE IRON COMPOUNDS,

NEBGEN, JOHN W. ; ENGELMANN WILLIAM H.; WEATHERMAN DOUGLAS F.

MIDWEST RESEARCH INST,

J ENV SCIENCES, MAY-JUN 81, V24, N3, P23 (5)

TECHNICAL FEATURE: STUDIES WERE CONDUCTED TO IDENTIFY CHEMICAL AGENTS FOR THE INHIBITION OF ACID MINE DRAINAGE FORMATION. THREE MATERIALS CONTAINING PYRITE WERE EVALUATED, BUT ONLY ONE WAS A STRONG PRODUCER OF ACID DRAINAGE. ANALYSIS OF RESULTS SUGGESTS THAT THE RATE AT WHICH PYRITE IS OXIDIZED CAN BE SUBSTANTIALLY REDUCED IF THE IRON PRODUCTS FROM PYRITE OXIDATION ARE KEPT INSOLUBLE. (2 GRAPHS, 6 REFERENCES, 3 TABLES)

152697 *81-005539

OCCURRENCE AND PREDICTION OF ACID DRAINAGES,

CARUCCIO, FRANK T. ; GEIDEL GWENDELYN; PELLETIER MIKE

UNIV OF SOUTH CAROLINA,

J ENERGY DIV-ASCE, MAY 81, V107, N1, P167 (12)

TECHNICAL REPORT: DURING LAND EXCAVATION ACTIVITIES, SULFIDE MINERALS ARE EXPOSED TO THE ATMOSPHERE. OXIDATION OCCURS, AND SUBSEQUENTLY, ACID DRAINAGES ARE PRODUCED. A METHOD TO MONITOR ROCK CHARACTERISTICS AND IDENTIFY POTENTIALLY ACID-PRODUCING STRATA HAS BEEN DEVELOPED. DARK SHALE SAMPLES WERE EXPOSED TO SIMULATED WEATHERING TESTS AND PERIODICALLY LEACHED WITH DEIONIZED WATER, SIMULATED ACID RAIN, AND SIMULATED ACID MINE DRAINAGE. A STRONG RELATIONSHIP WAS FOUND BETWEEN THE EFFLUENT QUALITY AND THE CARBONATE-SULFUR RATIO. (4 GRAPHS, 10 REFERENCES, 3 TABLES)

149452 *81-002426

ESTIMATION OF THE POTENTIAL OXIDATION RATE OF PYRITE IN COAL MINE SPOILS,

COLBOURN P.

UNIV OF NEWCASTLE-UPON-TYNE, UK,

RECLAMATION REVIEW, 1980, V3, N2, P121 (4)

TECHNICAL REPORT: PYRITE OXIDATION IN COLLIERY SHALES IS ESTIMATED. PYRITE OXIDATION LEADS TO EXTREME ACID CONDITIONS IN MINE SPOILS. CHEMICAL AND PHYSICAL CHARACTERISTICS OF COAL MINE SPOILS ARE DISCUSSED. MEASUREMENTS MADE OF PARTIAL PYRITE OXIDATION ARE REPORTED. FURTHER WORK IS NEEDED TO INVESTIGATE THE IMPORTANCE OF PYRITE OXIDATION TO LAND RECLAMATION MANAGEMENT. (6 REFERENCES, 2 TABLES)

147201 81-000249

SULFUR FRACTIONS AND DISTRIBUTION OF CARBON, NITROGEN, AND PHOSPHORUS IN PROFILES OF COAL MINES,

DICK, W. A. ; CHANCY, H. F. ; TABATABAI M. A.

IOWA STATE UNIV,

J ENV QUALITY, JUL-SEP 80, V9, N3, P455 (5)

TECHNICAL REPORT: STUDIES WERE CONDUCTED TO DETERMINE THE SULFUR FRACTIONS AND THE DISTRIBUTION OF ORGANIC AND INORGANIC CARBON, NITROGEN, AND PHOSPHORUS IN FOUR COAL PROFILES OBTAINED FROM IOWA COAL MINES. OVERBURDEN AND COAL SEAM ANALYTICAL DATA AND NUTRIENT CONCENTRATIONS ARE TABULATED. TOTAL NITROGEN VALUES WERE MUCH LOWER IN THE OVERBURDEN MATERIALS THAN IN THE COAL SAMPLES. SUCH DATA MAY PROVE VALUABLE IN PREPARING RECLAMATION OR MINING PLANS. (2 GRAPHS, 25 REFERENCES, 5 TABLES)

146367 *80-003176
ACID MINE WATERS IN SOUTH AFRICA AND THEIR AMELIORATION.
THOMPSON J. G.
SOIL & GAS RESEARCH INST, PRETORIA,
WATER SA, JUL 80, V6, N3, P130 (5)

RESEARCH REPORT: ACID MINE WATERS FORMED DURING THE CHEMICAL AND BACTERIAL OXIDATION OF PYRITES CONSTITUTE ONE OF THE BIGGEST WATER POLLUTION PROBLEMS IN SOUTH AFRICA. STUDIES WERE CONDUCTED TO DETERMINE THE RANGE IN CHEMICAL COMPOSITION OF ACID WATERS FROM THE MAJOR SOURCES. TECHNIQUES FOR NEUTRALIZING SUCH WATERS WERE INVESTIGATED ALSO. A TOTAL OF 30 ACID MINE WATER SAMPLES-18 OF COAL MINE ORIGIN, ONE FROM A GOLD MINE, AND 11 FROM GOLD MINE DUMPS-WERE ANALYZED. DATA DESCRIBING THE CHEMICAL COMPOSITIONS OF THE WATERS ARE TABULATED. HYDRATED LIME IS THE MOST SUITABLE NEUTRALIZING AGENT. (8 REFERENCES, 5 TABLES)

146200 80-006039
THE NATURE OF ACID MINE DRAINAGE REACTIONS AND THEIR RELATION TO OVERBURDEN ANALYSIS,
CARUCCIO FRANK T.
UNIV OF SOUTH CAROLINA,
PRESENTED AT INTL CONGRESS FOR ENERGY & ECOSYSTEM (PERGAMON) ECOL & COAL RESOURCE DEVEL CONF, GRAND FORKS, JUN 12-16, 78, V2, P778 (7)

TECHNICAL REPORT: OF THE STRATIGRAPHIC FACTORS CONTROLLING ACID MINE DRAINAGE CHARACTERISTICS AND CHEMICAL QUALITY OF NEAR SURFACE MINE SUBSTRATE, THE OCCURRENCE OF REACTIVE PYRITE APPEARS TO BE THE DOMINATING VARIABLE. THE ATTENDANT PROBLEMS OF ACID MINE DRAINAGE AND RECLAMATION EFFORTS CAN BE MINIMIZED BY ISOLATING THESE TOXIC PYRITE-CONTAINING MATERIALS FROM THE NEAR SURFACE ENVIRONMENT AND PLACING THEM IN A HYDROLOGICALLY ISOLATED REGION OF THE BACKFILLED MINE. THE DEVELOPMENT OF A BLANKET VEGETATION OF CALCAREOUS MATERIAL WILL ENHANCE THE PRODUCTION OF ALKALINITY OF INFILTRATING WATERS, WHICH WOULD NEUTRALIZE ACID PRODUCTION. (1 GRAPH, 8 REFERENCES)

145479 80-005346
ROTATING-DISC BIOLOGICAL TREATMENT OF ACID MINE DRAINAGE.
OLEM HARVEY ; UNZ RICHARD F.
(TVA) AND; (PENNSYLVANIA STATE UNIV),
WPCF J, FEB 80, V52, N2, P257 (13)

TECHNICAL REPORT: A STUDY WAS CONDUCTED TO DETERMINE IF SPECIFIC NATURALLY OCCURRING BACTERIA IN ACID MINE DRAINAGE WOULD EFFECTIVELY AND EFFICIENTLY OXIDIZE SOLUBLE FERROUS IRON. A PROTOTYPE ROTATING BIOLOGICAL CONTACTOR UNIT WAS EVALUATED UNDER CONDITIONS SIMULATING ACTUAL TREATMENT OF ACID MINE DRAINAGE OF VARYING PHYSICAL, CHEMICAL, AND MICROBIOLOGICAL CHARACTERISTICS. REQUIREMENTS FOR TREATMENT OF SPECIFIC DRAINAGES AND NECESSARY MODIFICATIONS TO ACCOMPLISH DESIRED EFFLUENT QUALITY WERE DETERMINED. UNDER ALL CONDITIONS, CONTINUOUS MICROBIOLOGICAL OXIDATION OF SOLUBLE FERROUS IRON WAS ACHIEVED. (2 DIAGRAMS, 15 GRAPHS, 2 PHOTOS, 17 REFERENCES, 8 TABLES)

145468 *80-005335
ALKALINE AND ACID PRODUCTION POTENTIALS OF OVERBURDEN MATERIAL: THE RATE OF RELEASE,
GEIDEL GWENDELYN
UNIV OF SOUTH CAROLINA,
RECLAMATION REVIEW, 1979, V2, N3-4, P101 (7)

RESEARCH REPORT: THE QUALITY OF COAL MINE DRAINAGE IS A FUNCTION OF THE BALANCE BETWEEN THE ACID AND ALKALINE PRODUCTION POTENTIALS. ACIDITY IS DERIVED FROM THE OXIDATION OF PYRITE AND THE SUBSEQUENT HYDROLYSIS OF THE WEATHERING PRODUCTS. ALKALINITY IS PRODUCED BY THE DISSOLUTION REACTION BETWEEN CALCIUM CARBONATE AND WATER. THE KINETICS OF EACH SYSTEM ARE EXAMINED. RATES OF REACTIONS OF THE TWO SYSTEMS WERE IDENTIFIED IN SIMULATED WEATHERING TESTS OF ACID AND ALKALINE PRODUCING ROCKS. RESULTS INDICATE THAT THE TIME INTERVAL BETWEEN FLUSHING IS CRITICAL TO THE PREVENTION OF ACIDIC DRAINAGES IN STRIPMINES THAT CONTAIN POTENTIALLY NEUTRALIZING MATERIALS. (16 GRAPHS, 6 REFERENCES)

145110 *80-004977
ACID MINE DRAINAGE AND SUBSIDENCE: EFFECTS OF INCREASED COAL UTILIZATION,
HILL, RONALD D. ; BATES EDWARD R.
EPA INDUSTRIAL ENV RESEARCH LAB, OHIO,
ENV HEALTH PERSPECTIVES, DEC 79, V33, P177 (14)

TECHNICAL REPORT: ONE OF THE MOST DAMAGING WATERBORNE CONTAMINANTS FROM COAL MINING OPERATIONS IS THE ACID GENERATED FROM THE EXPOSURE OF IRON SULFIDE MINERALS PRESENT IN COAL AND OVERBURDEN. INCREASED COAL CONSUMPTION CAN CAUSE AN INCREASE IN THE AMOUNT OF THIS POLLUTANT PRODUCED. INCREASES ABOVE 1975 LEVELS FOR ACID MINE DRAINAGE AND MINE SUBSIDENCE ARE PROJECTED THROUGH THE YEAR 2000. NO INCREASES ARE FORECASTED FOR ACID MINE DRAINAGE FROM SURFACE MINES SINCE ENFORCEMENT UNDER PRESENT LAWS SHOULD CONTROL THIS PROBLEM. THE INCREASE IN SUCH DRAINAGE FROM UNDERGROUND MINES IS PROJECTED TO BE 16% BY 1985 AND 10% BY 2000. MINE SUBSIDENCE IS EXPECTED TO INCREASE BY 34% AND 115% RESPECTIVELY FOR 1985 AND 2000. (2 DIAGRAMS, 13 REFERENCES, 11 TABLES)

144065 *80-004018
ASSOCIATIONS AMONG ACID MINE WATER PARAMETERS,
AKERS DAVID J.
WEST VIRGINIA UNIV COAL RESEARCH BUREAU REPORT 164, OCT 78 (16)

SPECIAL REPORT: A STUDY THAT DETERMINED THE EFFECT OF WATER PARAMETERS ON THE PHENOMENON OF ACID MINE DRAINAGE IS DESCRIBED. WATER SAMPLES FROM FOUR SEPARATE SITES OF A WEST VIRGINIA STREAM WERE ANALYZED FOR FERROUS IRON CONTENT, PH, AND CONCENTRATIONS OF MAGNESIUM, NICKEL, LEAD, COPPER, AND OTHER TRACE ELEMENTS. CHEMICAL REACTIONS AMONG THESE CONSTITUENTS COULD CAUSE THE RELEASE OF ACID WATER TO THE ENVIRONMENT. (4 REFERENCES, 5 TABLES)

143491 *80-003483
MINE SPOIL BANK HYDRAULICS,
PEARSON FRANK H.
UNIV OF CALIFORNIA, BERKELEY,
PRESENTED AT UNIV OF KENTUCKY/ET AL SURFACE MINING HYDROLOGY SYM, LEXINGTON, DEC 4-7, 79, P255 (9)

TECHNICAL REPORT: PRESENTED IS A METHOD OF ESTIMATING HYDROGRAPHS OF SEEPAGE FLOW FROM SPOIL BANKS OF SPECIFIED GEOMETRY, PERMEABILITY, AND POROSITY. WHEN SUCH HYDROGRAPHS ARE COMBINED WITH ESTIMATED TOTAL LOADINGS OF POLLUTANTS LEACHED FROM THE SPOIL, POLLUTOGRAPHS OF THE RATE OF DISCHARGE OF SULFATES, METALS, AND ACID WATERS FROM THE SPOIL BANK CAN BE DEVELOPED. THE ESTIMATION METHOD ALSO SHOWS THE RISING PROFILE OF THE WATER TABLE WITHIN A SPOIL BANK DURING RAINFALL, AND THE FALLING PROFILE AFTER RAIN. (4 DIAGRAMS, 1 GRAPH, 59 REFERENCES)

143477 *80-003469
INHIBITION OF PYRITE WEATHERING BY RECYCLING OF SELECTED EFFLUENTS,
WALSH, FRASER M. ; STONE ROBERT L.; ENGELMANN WILLIAM H.
ECO, MASS,
PRESENTED AT COAL AGE UNDERGROUND COAL MINING SYM, LOUISVILLE, OCT 23-25, 79, P139 (8)

TECHNICAL REPORT: PYRITE WEATHERING IS RESPONSIBLE FOR THE LARGE LOADS OF ACID AND IRON IN STREAMS ASSOCIATED WITH COAL MINE REGIONS OF APPALACHIA. THE MECHANICS OF PYRITE WEATHERING ARE EXAMINED, AND THE IMPORTANCE OF IRON BACTERIA IN CATALYZING PYRITE WEATHERING IS DETERMINED. A NEW APPROACH FOR IN SITU INHIBITION OF PYRITE WEATHERING IS DESCRIBED. PRELIMINARY RESULTS OF LABORATORY TESTS INDICATE THAT THE METHOD, WHICH IS BASED ON BREAKING THE PH-DEPENDENT SUCCESSION OF IRON BACTERIA RESPONSIBLE FOR CATALYZING THE RATE OF PYRITE WEATHERING, CAN REDUCE ACID AND IRON LOADS FROM COAL MINE OPERATIONS BY 80%. (2 GRAPHS, 6 REFERENCES, 5 TABLES)

140021 80-000115
CONTAMINATION OF GREAT SMOKY MOUNTAIN TROUT STREAMS BY EXPOSED ANAKEESTA FORMATIONS,
BACON, J. R. ; MAAS R. P.
WEST CAROLINA UNIV,
J ENV QUALITY, OCT-DEC 79, V8, N4, P538 (6)

RESEARCH REPORT: EXPERIMENTS WERE CONDUCTED TO INVESTIGATE THE CONTAMINATION BY EXPOSED ANAKEESTA FORMATIONS IN TROUT STREAMS OF THE GREAT SMOKY MOUNTAINS NAT'L PARK THAT OCCURRED AS A RESULT OF THE CONSTRUCTION OF U.S. HIGHWAY 441. DURING HIGHWAY CONSTRUCTION, ANAKEESTA FORMATIONS IN THE PARK WERE EXPOSED TO AIR AND WATER AND SUBSEQUENTLY RELEASED LEACHATE CONTAINING ACID AND HEAVY METALS. ACIDITY INVESTIGATIONS AT 11 SAMPLING SITES ALONG BEECH FLATS CREEK, WALKER PRONG, AND ALUM CAVE CREEK SHOWED THAT THE ANAKEESTA PYRITE USED AS LANDFILL FOR THE HIGHWAY WAS THE POINT SOURCE OF ACID CONTAMINATION. ZINC AND MANGANESE CONCENTRATIONS AT THE THREE STREAMS WERE ALSO HIGHER THAN WOULD OCCUR NORMALLY. THE EFFECT OF EXPOSED ANAKEESTA ON WATER QUALITY IS SIMILAR TO THE EFFECTS OF ACID MINE DRAINAGE IN COAL MINING REGIONS. (3 GRAPHS, 1 MAP, 18 REFERENCES, 3 TABLES)

136501 *79-003756
METHODS FOR THE CONTROL OF ENVIRONMENTAL DAMAGE CAUSED BY MINING ENERGY PRODUCING MATERIALS,
HILL, RONALD D. ; HARRIS EUGENE F.; HUBBARD S. JACKSON
EPA,
PRESENTED AT EPA ENERGY/ENV 3RD NATL CONF, WASH DC, JUN 1-2, 78, P165 (21)

SURVEY REPORT: ENVIRONMENTAL HAZARDS CAUSED BY MINING OPERATIONS INCLUDE CONTAMINATED WATER RUNOFF FROM DISTURBED AREAS AND DUST AND NOISE FROM BLASTING, EXTRACTION, AND HAULAGE ACTIVITIES. INACTIVE COAL MINES CONTRIBUTE 78% OF ACID MINE DRAINAGE, ACCORDING TO A 1969 CONGRESSIONAL STUDY. MINING METHODS THAT CAN BE USED TO CONTROL SEDIMENT, MINE DRAINAGE, SUBSIDENCE, AND DUST RELEASE ARE REVIEWED. WAYS TO CONTROL UNIQUE PROBLEMS ASSOCIATED WITH OIL SHALE AND URANIUM MINING ARE SUGGESTED. CURRENT R&D PROGRAMS CONDUCTED BY EPA AND OTHER BRANCHES OF THE FEDERAL GOVERNMENT ARE BRIEFLY SUMMARIZED. (1 DIAGRAM, 2 PHOTOS, 11 REFERENCES, 4 TABLES)

131587 •78-006245
AN EVALUATION OF PROBLEMS ARISING FROM ACID MINE DRAINAGE IN THE VICINITY OF SHASTA LAKE, SHASTA COUNTY, CALIFORNIA,
HOFFMAN, RAY J. ; FULLER RICHARD H.; SHAY JOHNEVAN M.; FERREIRA RODGER F.
USGS WATER RESOURCES REPORT 78-32, MAY 78 (39)

SPECIAL REPORT: THE STREAMS DRAINING IN THE MINED AREA OF MASSIVE SULFIDE ORE DEPOSITS IN THE EAST AND WEST SHASTA MINING DISTRICTS, CALIF., ARE GENERALLY ACID AND CONTAIN CONCENTRATIONS OF DISSOLVED METALS, WHICH ARE THE CAUSE OF NUMEROUS FISH KILLS IN SHASTA LAKE AND THE SACRAMENTO RIVER. THE EXTENT AND MAGNITUDE OF ACID AND METAL POLLUTION OF SHASTA LAKE ARE DETERMINED. METHODS OF MINIMIZING OR TREATING MINE EFFLUENT TO NEUTRALIZE THE PH AND TO REDUCE THE DISCHARGE OF DISSOLVED METALS ARE PRESENTED. A WATER QUALITY MONITORING PROGRAM THAT COULD BE USED TO EVALUATE THE EFFECTIVENESS OF TREATMENT OR ABATEMENT METHODS THAT MAY BE USED IN THE FUTURE IS SUGGESTED. METHODS OF TREATMENT INCLUDE THE USE OF AIR AND HYDRAULIC SEALING OF THE MINES, LIME NEUTRALIZATION OF MINE EFFLUENT, CHANNELING OF RUNOFF AND MINE EFFLUENT AWAY FROM MINE AND TAILING AREAS, AND THE GRADING AND SEALING OF MINE DUMPS. (1 DRAWING, 1 GRAPH, 4 MAPS, 19 REFERENCES, 7 TABLES)

131364 78-006052
RADIOLOGICAL INVESTIGATIONS OF AN ABANDONED URANIUM TAILINGS AREA,
MOFFETT, D. ; TELLIER M.
CANADA DEPT OF ENERGY, MINES, AND RESOURCES,
J ENV QUALITY, JUL-SEP 78, V7, N3, P310 (5)

RESEARCH REPORT: FIELD INVESTIGATIONS TO IDENTIFY AND CHARACTERIZE ALL RADIOACTIVE RELEASES FROM AN ABANDONED URANIUM TAILINGS AREA AT ELLIOT LAKE, CANADA, ARE DESCRIBED. SINCE MINING BEGAN 30 YR AGO IN THE AREA, TAILINGS SOLIDS WERE IMPOUNDED BY CONSTRUCTION OF DAMS. ACID GENERATED IN THE TAILINGS BY OXIDATION OF PYRITE HAS SOLUBILIZED SOME HEAVY METALS THAT CAN ESCAPE THROUGH EMBANKMENTS OR IN HEAVY RAINFALL OUTFLOWS. ACIDS AND RADIONUCLIDES ARE ALSO RELEASED IN UNACCEPTABLE QUANTITIES. RADIUM, POLONIUM, LEAD, URANIUM, AND THORIUM WERE LEACHED OUT OF TAILINGS IN SIGNIFICANT AMOUNTS. SAMPLES FROM THE WATER TABLE BENEATH THE TAILINGS SHOWED THAT WATER ACIDITY WAS DIRECTLY RELATED TO WEATHERING OF PYRITE IN THE TAILINGS. HIGH ACID WATER SAMPLES ALSO HAD HIGHER CONCENTRATIONS OF RADIOACTIVE ELEMENTS THAN LOW ACID WATER SAMPLES HAD. SEEPAGE SAMPLES BELOW THE TAILINGS DAM INDICATED THAT WATER QUALITY STANDARDS MAY BE EXCEEDED. (1 GRAPH, 2 MAPS, 12 REFERENCES, 2 TABLES)

131094 78-005782
AN AQUEOUS AND SEDIMENTALOGICAL MODEL FOR HEAVY METAL CONTAMINATION OF STREAM SYSTEMS AFFECTED BY SULFIDE MINING IN THE EASTERN UNITED STATES,
SCHRADER, ED L. ; FURBISH WILLIAM J.
DUKE UNIV,
B ENV CONTAM & TOX, AUG 78, V20, N2, P159 (8)

RESEARCH REPORT: TRENDS IN THE ACCUMULATION AND DISTRIBUTION OF POTENTIALLY TOXIC TRACE METALS IN FLUVIAL SYSTEMS THAT DRAIN ABANDONED SULFIDE MINERAL MINING OPERATIONS ARE ASSESSED. WATER AND SEDIMENT SAMPLES WERE TAKEN FROM THE STREAM VALLEY ADJOINING THE ''LITTLE BOB'' MINE IN PAULDING COUNTY, GA., AND TESTED FOR SUSPENDED PARTICULATES, PH, AND TRACE METALS TO DETERMINE THE EFFECTS OF SULFIDE ORE MINING ON WATER QUALITY. LEVELS OF IRON, MANGANESE, CADMIUM, ZINC, COPPER, NICKEL, AND LEAD IN THE WATER ARE TABULATED. LEVELS IN A TAILINGS POND AND THE STREAM EXCEEDED SAFETY STANDARDS FOR HUMAN CONSUMPTION. HEAVY METAL CONTAMINATION OF STREAMS NEAR MINES MAY BE A FUNCTION OF THE CYCLIC PRECIPITATION AND DISSOLUTION OF IRON-MANGANESE OXYHYDROXIDES. FEW PRIVATE COMPANIES ARE WILLING TO REGULATE RATES OF METAL CONTAMINATION IN MANY OF THE ABANDONED MINES; THE WATERS PRESENT A HAZARD FOR NEARBY RURAL COMMUNITIES AND SURROUNDING ECOLOGICAL SYSTEMS. (1 MAP, 13 REFERENCES, 3 TABLES)

129260 •78-004154
PALEOENVIRONMENT OF COAL AND ITS RELATION TO DRAINAGE QUALITY,
CARUCCIO, FRANK T. ; FERM JOHN C.; HORNE JOHN; GEIDEL GWENDELYN; BAGANZ BRUCE
UNIV OF SOUTH CAROLINA,
EPA INTERAGENCY ENERGY-ENVIRONMENT R&D REPORT EPA-600/7-77-067, JUN 77 (108)

SPECIAL REPORT: THE PALEOENVIRONMENT OF COALS AND ASSOCIATED STRATA WERE ANALYZED TO DETERMINE THE ACID PRODUCTION POTENTIAL OF A COAL. COALS AND ASSOCIATED COAL FIELDS FROM THE APPALACHIAN COAL FIELD OF EASTERN KENTUCKY WERE CHARACTERIZED AS EITHER BACK-BARRIER, LOW DELTA PLAIN, OR UPPER DELTA PLAIN. PALEOENVIRONMENT SAMPLES WERE ANALYZED FOR SULFUR CONTENT AND PYRITE TYPES. BACK-BARRIER AND LOWER DELTA PLAIN STRATA HAD A HIGHER PERCENTAGE OF REACTIVE PYRITE THAN THE STRATA OF THE UPPER DELTA PLAIN HAD. BACK-BARRIER AND LOWER DELTA PRODUCED COALS OF SIMILAR SULFUR CONTENTS, AND BOTH CONTAINED VARYING PERCENTAGES OF FRAMBOIDAL PYRITE. DIFFERING WATER CHEMISTRY CAUSED ACID MINE DRAINAGE TO BE ASSOCIATED WITH THE BACK-BARRIER AND LOWER DELTA PLAIN STATE, THOUGH REACTIVE PYRITE WAS PRESENT IN THE SEAMS OF BOTH PALEOENVIRONMENTS. PYRITE DISTRIBUTION AND WATER CHEMISTRY PRODUCING ACIDIC OR NEUTRAL DRAINAGES WERE CORRELATIVE WITH THE PALEOENVIRONMENT OF THE COALS AND ASSOCIATED STRATA. (1 DIAGRAM, 13 GRAPHS, 5 MAPS, 14 PHOTOS, 42 REFERENCES, 6 TABLES)

122842 *77-004859
SIXTH SYMPOSIUM ON COAL MINE DRAINAGE RESEARCH,
NATL COAL ASSN/BITUMINOUS COAL RESEARCH COAL CONF AND EXPO III PROCEEDINGS, LOUISVILLE, OCT 19-21, 76 (300)

SPECIAL REPORT: THE VARIOUS ASPECTS OF COAL MINE DRAINAGE RESEARCH ARE DISCUSSED IN A SERIES OF PAPERS ON SUCH TOPICS AS: THE CHARACTER OF DRAINAGE AS A FUNCTION OF THE OCCURRENCE OF FRAMBOIDAL PYRITE AND GROUNDWATER QUALITY IN EASTERN KENTUCKY; COAL PILE LEACHATE QUANTITY AND QUALITY CHARACTERISTICS; WATER QUALITY RELATIONSHIPS AS A FUNCTION OF ACID MINE DRAINAGE INPUTS INTO THE SUSQUEHANNA RIVER; EFFECTS OF STRIPMINING ON STREAM WATER QUALITY; COMBINATION LIMESTONE-LIME TREATMENT OF ACID MINE DRAINAGE; ALUMINA-LIME-SODA PROCESS PARAMETERS FOR RECOVERING POTABLE WATER FROM ACID MINE DRAINAGE; FEASIBILITY OF USING REVERSE OSMOSIS TO TREAT ACID MINE WATER; MICROBIAL OXIDATION OF FERROUS IRON IN COAL MINE DRAINAGE TREATMENT; DISPOSAL OF SLUDGE FROM ACID MINE DRAINAGE NEUTRALIZATION; A CRITICAL REVIEW OF SEDIMENTATION PONDS; AND AN INTERGOVERNMENTAL PROJECT TO IMPROVE ENVIRONMENTAL QUALITY IN AN AREA OF ABANDONED MINES. (19 DIAGRAMS, 51 GRAPHS, 6 MAPS, 37 PHOTOS, 166 REFERENCES, 75 TABLES)

114813 76-006013
BACTERIAL ECOLOGY OF STRIP MINE AREAS AND ITS RELATIONSHIP TO THE PRODUCTION OF ACIDIC MINE DRAINAGE,
DUGAN PATRICK R.
OHIO STATE UNIV.
OHIO J SCIENCE, NOV 75, V75, N6, P266 (14)

SURVEY REPORT: THE ACTIVITY OF ACIDOPHILIC BACTERIA AS AGENTS INVOLVED IN PRODUCTION OF SULFURIC ACID FROM IRON PYRITE FOUND IN ASSOCIATION WITH COAL MINE REFUSE OR SPOILS IS REVIEWED. DATA DEMONSTRATE THE INHIBITORY EFFECT OF ANIONIC DETERGENTS AND CERTAIN ORGANIC ACIDS ON THE GROWTH AND METABOLISM OF THE ACIDOPHILIC THIOBACILLI. THE INFLUENCE OF ACIDIC MINE DRAINAGE ON MICROFLORA OF NON-ACID POLLUTED STREAMS IS CONSIDERED, AND THE HETEROTROPHIC MICROBES THAT ARE INDIGENOUS TO ACID STREAMS AND ACID COAL REFUSE ARE DISCUSSED. THE POTENTIAL FOR SULFATE REDUCING BACTERIA TO REMOVE H 2SO 4 FROM STREAMS IS SURVEYED. (2 DIAGRAMS, 7 GRAPHS, 3 PHOTOS, 50 REFERENCES, 1 TABLE)

106662 75-006540
MINE DRAINAGE POLLUTION REDUCTION BY INHIBITION OF IRON BACTERIA,
WALSH, FRAZER ; MITCHELL RALPH .HARVARD UNIV.
WATER RESEARCH, MAY-JUN 75, V9, N5-6, P525 (4)

RESEARCH REPORT: THE MAJORITY OF IRON AND ACIDITY RELEASED IN COAL MINE DRAINAGE IS THE RESULT OF PYRITE DEGRADATION BY FERRIC IRON. PERFUSION OF COAL MINE TAILINGS WITH IRON-RICH SYNTHETIC GROUNDWATER IS SHOWN TO SIGNIFICANTLY REDUCE RATES OF TOTAL IRON AND ACIDITY RELEASE FROM THE TAILINGS. THE INCREASED INFLUENT FERROUS IRON CONCENTRATION INHIBITED THE CATALYTIC ACTIVITY OF THE IRON BACTERIA BY PREVENTING THE GROWTH OF SIGNIFICANT METALLOGENIUM POPULATIONS. A COMBINATION OF INCREASING MINE INFLUENT FERROUS IRON CONCENTRATIONS WITH MINE SEALING MAY GREATLY REDUCE ACIDITY AND TOTAL IRON RELEASES FROM WORKING OR ABANDONED COAL MINES. (1 GRAPH, 5 TABLES)

101488 *75-001475
METHODS AND COSTS FOR STABILIZING FINE-SIZED MINERAL WASTES,
DEAN, K.C. ; HAVENS RICHARD; GLANTZ M.W.
USBM,
NTIS REPORT PB-233 426/6WP, MAY 74 (31)

SPECIAL REPORT: FINE-SIZED MINERAL WASTES DISCARDED BY ORE MILLING PLANTS REQUIRE STABILIZATION TO PREVENT AIR AND WATER POLLUTION. STABILIZATION HAS BEEN ATTAINED BY PHYSICAL, CHEMICAL, VEGETATIVE, AND COMBINATION PROCEDURES. VEGETATIVE RECLAMATION, PREFERABLE TO PHYSICAL AND CHEMICAL STABILIZATION, IS DIFFICULT TO ACHIEVE BECAUSE THE WASTES ARE STERILE, CONTAIN DELETERIOUS INORGANIC SALTS, AND LACK OF ESSENTIAL NUTRIENTS AND PHYSICAL CHARACTERISTICS REQUIRED FOR SUSTAINING VEGETATIVE GROWTH. PROCEDURES DEVELOPED BY USBM AND INDUSTRY FOR VEGETATING AMENABLE TAILINGS ARE SUMMARIZED, COSTS FOR THE VARIOUS PROCESSES ARE LISTED, AND PROCEDURES THAT MAY BE APPLICABLE FOR STABILIZING SALINE AND PYRITE-CONTAINING TAILINGS ARE SUGGESTED. RIDGED PLANTING BEDS, DRIP IRRIGATION, AND DEEP FURROW PLANTING TECHNIQUES ARE SUGGESTED FOR STABILIZING SALINE WASTES. A COMBINATION OF MILL TAILINGS AND SEWAGE SLUDGE CAN BE USED FOR PRODUCING SYNTHETIC SOILS, AND LAYERS OF SEWAGE SLUDGE BURIED UNDER A LAYER OF TAILINGS OFFER PROMISE OF INHIBITING ACID FORMATION FROM OXIDATION OF SULFIDES IN MINERAL WASTES.

100259 +75-000260
REMOVAL OF HEAVY METALS FROM MINE DRAINAGE BY PRECIPITATION,
ROSS LAURENCE W.
NATL FIELD INVESTIGATIONS CENTER, DENVER.
EPA ENV PROTECTION TECHNOLOGY SERIES REPORT EPA-670/2-73-080, USGPO, SEP 73 (74)

SPECIAL REPORT: HEAVY METALS IN MINE DRAINAGE WATERS OF THE ROCKY MOUNTAINS CAN BE REMOVED BY A TWO-STAGE PROCESS: NEUTRALIZATION FOLLOWED BY SULFIDE TREATMENT. THE FIRST STAGE REMOVES ALUMINUM AND FERRIC HYDROXIDES, AND THE SECOND STAGE PRECIPITATES THE MOST ENVIRONMENTALLY OBJECTIONABLE HEAVY METALS AND THOSE OF POSSIBLE RECOVERY VALUE. A COMPUTER PROGRAM BASED ON PUBLISHED VALUES OF EQUILIBRIUM CONSTANTS AND SOLUBILITY-PRODUCT CONSTANTS CAN ADEQUATELY PREDICT THE REQUIRED CHEMICAL QUANTITIES FOR TREATMENT AND OF THE RESULTING METAL CONCENTRATIONS IN SOLUTION. THE ECONOMICS OF CHEMICAL ADDITION INDICATES THAT RECOVERY OF SULFIDES FOR SALE TO SMELTERS CAN PARTIALLY OFFSET THE TREATMENT COST. (2 DIAGRAMS, 18 GRAPHS, 2 PHOTOS, 1 TABLE)

024267 +73-008880
PYRITIC SYSTEMS, A MATHEMATICAL MODEL,
NORTH, ARTHUR H.; SHUMATE, KENESAW S.; SMITH, EDWIN E.
WATER POLL CONT RES SER 14010 EAH EPA USGPO NOV 72 (171)

008529 +72-001997
EFFECT VARIOUS GAS ATMOS. ON OXIDATION COAL MINE PYRITES,
WATER POLLU CONTROL RSRCH SERIES AUG 71 (140)

APPENDIX I

POLLUTION ABSTRACTS DATABASE

SEARCH #1 OF 2

SEARCH STRATEGY:

[ACID AND MINE DRAINAGE]

AND

[PYRIT? OR SULPHIDE OR SULFIDE]

83-07861
Atmosphere and temperature within a reclaimed coal-stripmine and a numerical simulation of acid mine drainage from stripmined lands
Jaynes, D.B.
Pennsylvania State Univ., University Park, PA, USA
DISS. ABST. INT. PT. B - SCI. & ENG VOL. 44, NO. 1, Publ.Yr: 1983
SUMMARY LANGUAGE - ENGLISH; Order No. FAD DA8312634
Languages: ENGLISH

Oxygen, O sub(2), and carbon dioxide, CO sub(2), and temperature were measured with depth along a transect of an acid, reclaimed coal stripmine over a two-year period. Spoil atmosphere O sub(2) concentrations decrease with depth but approach zero only in a small portion of the transect. Most of the mine remains well oxygenated down to 12 meter depth. CO sub(2) concentrations ranged from near atmospheric levels to greater than 15%. At some locations, especially within 2 meters of the surface, variations in O sub(2) and CO sub(2) are correlated with changes in the spoil temperature. Spoil temperatures in layers below 3 meters remain in a range conductive to iron-oxidizing bacterial activity year around. Flux ratios of CO sub(2) and O sub(2) and source/sink rates of the two gases indicate that carbonate neutralization of the acid produced by pyrite oxidation is the dominant source of CO sub(2).

83-03621
Placement of acid spoil materials
Pionke, H.B.; Rogowski, A.S.
USDA-SEA-AR, Northeast Watershed Res. Cent., University Park, PA 16802, USA
RECLAM. AND REVEGET. RES VOL. 1, NO. 1, pp. 3-17, Publ.Yr: 1982
SUMMARY LANGUAGE - ENGLISH
Languages: ENGLISH

Potentially there are several chemical and hydrologic problems associated with placement of acid spoil materials. The rationale for a deep placement well below the soil surface, and preferably below a water table, is to prevent or minimize oxidation of pyrite to sulfuric acid and associated salts by reducing the supply of oxygen. If, however, substantial sulfuric acid or associated salts are already contained within the spoil because of present or previous mining, handling and reclamation operations may actually increase the rate of acid and salt leaching. Specific placement of acid- and salt-containing spoil should be aimed at preventing contact with percolating water or rising water tables.

83-02138
Response of sulfide-affiliated copper, nickel, and zinc in shale overburdens associated with coals to simulated leaching
Chen, H.S.
Univ. South Carolina, Columbia, SC, USA
DISS. ABST. INT. PT. B - SCI. & ENG VOL. 43, NO. 4, Publ.Yr: 1982
SUMMARY LANGUAGE - ENGLISH; Order No. FAD DA8220193.
Languages: ENGLISH

Dynamic leaching simulating the hydrogeochemical conditions of the backfilled coal mine spoil bank was conducted to study the behavior of sulfide-affiliated Cu, Ni, and Zn of the black shales during chemical weathering. The black shale samples with total sulfur content ranging from 0.4% to over 3.0% were leached at weekly intervals with distilled-deionized water, synthetic rainwater, and synthetic acid mine drainage respectively. The chemical properties of the leachates were influenced by the chemistry of the leachants as well as by the interactions of pyrite oxidation and carbonate neutralization. Rocks with low sulfur content and high neutralization potential produced alkaline leachates when drained with rainwater, and consequently no trace metals were released.

83-02103
Reclamation of toxic mine waste utilizing sewage sludge Contrary Creek demonstration project
Hinkle, K.R.
Virginia State Water Control Board, Bridgewater, VA, USA
Publ.Yr: 1982
NTIS, SPRINGFIELD, VA
SUMMARY LANGUAGE - ENGLISH; PB82-227521.
Languages: ENGLISH

Three abandoned pyrite mines in central Virginia that had been inactive since 1923 contained about 12 denuded ha and caused severe acid mine drainage (AMD) in a small stream known as Contrary Creek. The AMD included heavy metals and rendered the stream virtually void of aquatic life. The Virginia State Water Control Board (SWCB) was prompted to seek a solution to this problem when plans were announced in 1968 to construct a reservoir for a nuclear power plant downstream from Contrary Creek. Two of the mines comprising about 8 ha were reclaimed with an Environmental Protection Agency (EPA) demonstration grant with the SWCB contributing matching funds by in-kind services and the Soil Conservation Service providing technical assistance. Reclamation began in 1976 and included the use of sewage sludge as a soil conditioner.

83-01929

MINES: a model to forecast mine wastewater quality

Bell, J.F.; Reeves, M.J.

Eng. Geol. Lab., Univ. Durham, South Road, Durham DH1 3LE, UK

INT. J. ENVIRON. STUD VOL. 20, NO. 1, pp. 47-52, Publ.Yr: 1982

SUMMARY LANGUAGE - ENGLISH

Languages: ENGLISH

The factors affecting the production of polluting acid and ferruginous mine wastewaters are briefly reviewed and possible mechanisms affecting the chemical breakdown of pyritic material are discussed. A probability model formulation procedure is suggested, including a description of the model MINES which was developed to forecast the likelihood and type of acid and ferruginous mine drainage occurring in a specific situation. Some predictions from runs on MINES are presented and compared against actual field observations.

83-01881

Evaluation of a surface application of limestone for controlling acid mine discharges from abandoned strip mines, [illegible]owellsville, Ohio

Geidel, G.

Univ. South Carolina, Columbia, SC, USA

DISS. ABST. INT. PT. B - SCI. & ENG VOL. 43, NO. 4, Publ.Yr: 1982

SUMMARY LANGUAGE - ENGLISH; Order No. FAD DA8220201

Languages: ENGLISH

A 150 acre drainage basin in an unreclaimed coal strip mine in east-central Ohio was studied and extensively monitored to determine the effect of a surface application of limestone on the ground water quality. Prior to the limestone treatment the ground and surface water of the basin was acidic due to pyrite oxidation in the spoil. The results of this field study and simultaneous laboratory experiments showed that the maximum amount of alkalinity that can be generated by a surface application of limestone is not sufficient to reduce the ground water acidity generated by pyrite oxidation. Additionally, the amount of limestone applied was not sufficient to significantly decrease the rate of pyrite oxidation nor provide neutralization and thereby produce neutral or alkaline discharges from the abondoned coal strip mine sites.

82-08020

Evaluation of Acid Production Potential of Mining Waste Materials

Bruynesteyn, A.; Hackl, R.P.

Div. Extractive Metall., BC Res., 3650 Wesbrook Mall, Vancouver, BC, Canada V6S 2L2

MINER. ENVIRON VOL. 4, NO. 1, pp. 5-8, Publ.Yr: 1982

SUMMARY LANGUAGE - ENGLISH

Languages: ENGLISH

materials is discussed and the chemistry involved explained. The bacterium Thiobacillus ferrooxidans plays an important role in acid production due to its ability to rapidly oxidize reduced forms of iron and sulphur which can result in the generation of H sub(2)SO sub(4). The sulphide mineral pyrite (FeS sub(2)), often present in waste materials, is generally recognized as the chief source of acid mine drainage. A small-scale test procedure has been developed which rapidly evaluates a waste material's capability to produce an acidic effluent. If the material is assessed as a potential acid producer, then scale-up testing procedures are available which can be used to simulate the characteristics of the effluents produced from a commercial-size waste dump. During periods of little rainfall, localized biological activity may occur in wet areas of a waste dump, resulting in possible accumulation of soluble pollutants. The length of these dry periods greatly affects effluent characteristics during subsequent rainfalls.

81-07188

Treatment of Acid Mine Drainage

Throop, W.M.

Envirex Inc., Rexnord Co., Waukesha, WI

INDUST. WASTES VOL. 27, NO. 2, pp. 28-30, Publ.Yr: 1981

Languages: ENGLISH

Acid mine water results from the exposure of sulfur and iron-bearing materials to processes of erosion and weathering. Acid is formed when iron sulfide, known as pyrite, oxidizes with mine waters to form a weak solution of sulfuric acid. Pyrite occurs naturally in close proximity to coal seams. Coal mining exposes vast quantities of pyritic material which ultimately results in large quantities of acid mine drainage. When the acid passes over the rock strata surrounding the pyrite, it dissolves such metals as aluminum, iron manganese, calcium, magnesium, sodium and a variety of trace metals.

81-06920

Production of Acid Water in a Lead-Zinc Mine, Coeur d'Alene, Idaho

Wai, C.M.; Reece, D.E.; Trexler, B.D.; Ralston, D.R.; Williams, R.E.

Dept. Chem. & Dept. Geol., Univ. ID, Moscow

ENVIRON. GEOL VOL. 3, NO. 3, pp. 159-162, Publ.Yr: 1980

Languages: ENGLISH

The Bunker Hill Mine in Idaho's Coeur d'Alene mining district produces approximately 10 m super(3)/minute of acid water containing high concentrations of heavy metals. Field and laboratory studies indicate that much of the acid water is produced in a single ore body in the upper part of the mine. The ore of this body contains mainly sphalerite, galena, and pyrite in a siderite-quartz gangue. Ground water recharges this ore body through a near-vertical zone of high permeability, which is the result of mining by the caving technique. Ore samples from the caving area contained oxidized forms of iron and produced acid in a laboratory leaching test. Leaching experiments with several ore samples from the mine also indicated that the ratio of pyrite to calcite in the samples strongly controlled the resultant pH values.

81-05785

Inhibition of Acid Mine Drainage Formation: The Role of Insoluble Iron Compounds

Nebgen, J.W.; Engelmann, W.H.; Weatherman, D.F.

Midwest Res. Inst.

J. ENVIRON. SCI VOL. 25, NO. 3, pp. 23-26, Publ.Yr: 1981

Languages: ENGLISH

This paper contains findings and conclusions from a 2-year study concerning chemical agents for the inhibition of acid mine drainage (AMD) formation. Three materials containing pyrite were evaluated in detail, but only one was a strong producer of AMD. Analysis of the experimental results strongly suggests that the rate at which pyrite is oxidized can be lowered substantially if the iron products from pyrite oxidation are kept insoluble. Analysis of the data does not distinguish between the following mechanisms: the lack of availability of soluble ferric ion as an oxidant or the exclusion of air by a ferric hydroxide coating. Either mechanism is compatible with the experimental data. Thus, methods to keep aqueous ferric ion minimized, e.g., through insolubilization or maintaining high Fe super(+) super(+)/Fe super(+) super(+) super(+) ratios, appear to be important in the chemical inhibition of AMD formation.

81-00825

Sulfur fractions and distribution of carbon, nitrogen, and phosphorus in profiles of coal mines.

Dick, W. A.; Chancy, H. F., Jr.; Tabatabai, M. A.

Iowa State Univ., Dept. of Agronomy, Ames, IA 50011

JOURNAL OF ENVIRONMENTAL QUALITY 9(3), 455-459, Coden: JEVQAA Publ.Yr: Jul-Sep, 1980

illus. refs.

Abs.

Languages: ENGLISH

Doc Type: JOURNAL PAPER

Analysis of samples of 4 profiles-2 containing calcareous shale and 2 acid shale-from a coal mine in Iowa showed that the total S content of the coal seam under acid shale ranged from 9% to 10% and of the coal under calcareous shale was ~5%. Zinc-HCl-reducible S always exceeded the Raney Ni-reducible S. With the exception of 1 coal sample under acid shale that contained an appreciable amount of sulfide S, all the shale and coal samples contained small amounts of sulfide S. The shale samples generally contained greater amounts of pyrite S (52-85%) than did the coal samples (35-63%). Pyrite S was significantly correlated with total S in the shale and coal samples studied. Total N values were much lower in the overburden materials (0.01-0.13%) than in the coal samples (0.65-0.81%). Total P content was the greatest in the shale samples. The coal seam under acid shale contained greater P concentrations, with the organic P fraction exceeding the inorganic P, than did the coal seam under the calcareous shale, where the amounts of organic and inorganic P fractions were similar. The S fractions in the various horizons of the profiles studied and the relationships among organic C, N, and P are discussed. (AM)

80-07766
Alkaline and acid production potentials of overburden material: The rate of release.
Geidel, G.
Univ. of South Carolina, Dept. of Geology, Columbia, SC 29208
RECLAMATION REVIEW 2(3-4), 101-107, Coden: REREDB
Publ.Yr: 1979
illus. refs.
Abs.
Languages: ENGLISH
Doc Type: JOURNAL PAPER

The quality of coal mine drainage is a function of the balance between the acid and alkaline production potentials. The acidity is derived primarily from the oxidation of pyrite and the subsequent hydrolysis of the weathering products. Alkalinity is produced by the dissolution reaction between calcium carbonate ($CaCO_3$) and water. The kinetics of both systems are different and the concentrations of acidity or alkalinity are time dependent. Simulated weathering tests of acid and alkaline producing rocks showed different rates of reactions. The amount of acidity released was proportional to the time interval between flushings and may possibly be explained by the continued oxidation of pyrite through time. The degree of accumulation of weathering products which are readily soluble in water, is correlative with the degree of acidity released at the time the sample is rinsed with water. Alkalinity production, however, is limited by the solubility of $CaCO_3$ in water which, at a given partial pressure of CO_2, has a maximum neutralizing potential. Simulated weathering tests indicated that the amount of alkalinity produced at various flushing intervals was similar. The time interval between flushing is critical to the prevention of acidic drainages in strip mines that contain potentially neutralizing material. (AM)

80-03182
Impact of western coal mining-II. Microbiological studies.
Olson, G. J.; Turbak, S. C.; McFeters, G. A.
Montana State Univ., Dept. of Microbiology, Bozeman, MT 59717
WATER RESEARCH 13(11), 1033-1041, Coden: WATRAG
Publ.Yr: 1979
illus. refs.
80-03180 Abs.
Languages: ENGLISH
Doc Type: JOURNAL PAPER

The occurrence and activity of certain groups of S cycle bacteria associated with waters, sediments, and the coal bearing strata of a coal strip mine at Decker, Montana, were studied. Mining areas in northeastern Wyoming were also examined. Thiobacillus ferrooxidans, one of the major contributors to acid mine drainage, was consistently detected in the mining environment. Physiological studies of T. ferrooxidans isolates indicated that these acidophilic Fe and S oxidizing organisms were typical of the species in their preference for low pH and ability to oxidize pyrite. Since acidic conditions were not observed at Decker, the organisms did not multiply in mine water environments and no acid could be formed from coal samples inoculated with a T. ferrooxidans isolate, their activity was apparently limited to microzones in the coal bearing strata where they oxidized sulfuritic material. Any acid formed was quickly neutralized by mineral carbonates associated with the groundwaters and overburden. Sulfate reducing bacteria also were common in the mine waters and sediments. These organisms were particularly active in the sedimentation pond sediments as was evidenced by the rapid rate of conversion of radiolabeled sulfate to sulfide. The hydrogen sulfide produced by these organisms contributed to heavy metal precipitation in the sedimentation pond. (AM)

79-06649
Bacterial streamer growth in a disused pyrite mine.
Johnson, D. B.; Kelso, W. I.; Jenkins, D. A.
Univ. College of North Wales, Dept. of Biochemistry and Soil Science, Bangor, Gwynedd, LL57 2UW, Wales
ENVIRONMENTAL POLLUTION 18(2), 107-118, Coden: ENVPAF
Publ.Yr: Feb. 1979
illus. refs.
Abs.
Languages: ENGLISH
Doc Type: JOURNAL PAPER

A disused pyrite mine in the Conwy Valley, North Wales, contained copious amounts of acid drainage of the heterotrophic bacterial origin. The geology of the mine is discussed, and analytical data on the acid stream which flows through the mine are presented. The UV and visible spectra of the typically orange-red-colored water identified ferric hydroxide, ferric sulfate, and ferric disulfate as the main ionic species responsible for the color. There were also high concentrations of Al, Mg, and Ca. Organic C, pH, P, and N were low. The acid drainage has destroyed a swathe of trees in route to the River Conwy. (AM)

79-01858
Leachate from disposal of FGD sludges in deep mines.
Rapp, J. R.; Duvel, W. A., Jr.; Atwood, R. A.; et al.
Michael Baker, Jr., Inc., Box 280, Beaver, PA 15009
71st APCA annual meeting and exhibition Houston, Tex. June 25-30, 1978
Air Pollution Control Association 71st annual meeting and exhibition: Abstracts of papers Publ.Yr: 1978
Publ: Pittsburgh, Pa. Air Pollution Control Association
Abs. only
Languages: ENGLISH
Doc Type: CONFERENCE PAPER

A series of leachate experiments was conducted by leaching synthetic acid mine drainage through samples of fixed and unfixed FGD sludges from 2 western Pennsylvania power plants. The data indicate that heavy metal leaching problems from deep mine disposal will probably not occur, provided the sludges are sufficiently alkaline and the mine is filled. Leaching of sulfate, calcium, sodium, and potassium can be anticipated; leaching of sulfite is not expected, however, provided the pH of the sludge is sufficiently high. There is an indication that hydrogen sulfide may be generated in some instances, possibly resulting in problems of increased odors, suspended metal sulfides, and COD. . (AM)

79-00453
An evaluation of problems arising from acid mine drainage in the vicinity of Shasta Lake, Shasta County California.
Fuller, R. H.; Shay, J. M.; Ferreria, R. F.; et al.
USGS, Water Resources Div., 345 Middlefield Rd., Menlo Park, CA 94025
U.S. GEOLOGICAL SURVEY. WATER RESOURCES INVESTIGATIONS
Coden: WRIND3 43 pp Publ.Yr: May 1978
illus. refs.
Abs.
Languages: ENGLISH

Streams draining the mined areas of massive sulfide ore deposits in the East and West Shasta Mining Districts of northern California are generally acid and contain large concentrations of dissolved metals (Fe, Cu, and Zn). The streams (Flat, Little Backbone, Spring, West Squaw, Horse, and Town creeks) discharging into Shasta Lake and the Sacramento River have caused numerous fish kills. The major source of pollution is discharge from underground mines. A secondary source of pollution is streamflow and surface runoff that has passed through mine dumps where the oxidation of pyrite and other sulfide minerals results in the production of acid and the mobilization of metals. Suggested methods of abatement include air sealing and hydraulic sealing of the mine; lime neutralization of mine effluent; channeling runoff and mine effluent away from mine and tailing areas; and grading and sealing of mine dumps. A comprehensive preabatement and postabatement monitoring program is recommended to evaluate the effects of any treatment method used. (AM)

78-05030
Microbiological removal of sulfur from a pulverized coal blend.
Dugan, P. R.; Apel, W. A.
Ohio State Univ., Dept. of Microbiology, 484 W. 12th Ave., Columbus, OH 43210
Third symposium on coal preparation Louisville, Ky. Oct. 18-20, 1977
Third symposium on coal preparation: Papers pp. 10-21 Publ.Yr: 1977
Publ: Washington, D.C. National Coal Association
illus. refs.
No abs.
Languages: ENGLISH
Doc Type: CONFERENCE PAPER

Thiobacillus ferrooxidans cultures were grown under forced aeration at ambient temperature in 9K medium. Natural coal enrichment cultures and pyrite enrichment cultures were obtained by inoculating appropriate slurries with acid mine drainage and incubating at ambient temperature for 4 wk. Coal slurries of different concentrations (10%-50%) were prepared and inoculated with the coal enrichment cultures. Enrichment cultures produced a significant rate of sulfate (SO4-2) release from the coal, but inoculation with the pure T. ferrooxidans culture did not increase SO4-2 release over controls. With a 10% coal slurry, pyritic S decreased from 2.9% to 0.1%, and total S from 4.1% to 1.8%. With a 20% slurry, 0.5% of the original 4.2% pyritic S and 2.0% of the original 5.4% total S remained after 23 d. The net removal of SO4-2 for 20% and 40% slurries was increased slightly by addition of ammonium sulfate. Pyritic S was not completely removed from the 30%, 40%, or 50% slurries, but the absolute amount of S removed was greater as the percent slurry increased. (FT)

78-00260
Modeling the impact of strip mining and reclamation processes on quality and quantity of water in mined areas: A review.
Rogowski, A. S.; Pionke, H. B.; Broyan, J. G.
ARS, Northeast Watershed Research Center, University Park, PA 16802
JOURNAL OF ENVIRONMENTAL QUALITY 6(3), 237-244, Coden: JEVQAA Publ.Yr: July-Sept. 1977
illus. numerous refs.
Abs.
Languages: ENGLISH

Current literature contains numerous studies of acid generation, neutralization, and transformation in strip-mine spoil materials, yet the rate-determining processes on the field scale are not well understood. Even less seems to be known about the spoil water flow, oxygen diffusion, surface runoff, erosion, evapotranspiration, and temperature distributions within the spoil banks. Most spoils have been considered from the standpoint of rapid revegetation, use of amendments, and favorable placement of acid-producing materials. Hydrology of the spoil system could be simulated using standard modeling techniques. Experimentally obtained temperature and oxygen distributions could delineate acid-producing areas, assuming pyrite is not limiting, and is distributed evenly throughout the zone of interest. (AA)

72-07489 72-6TB-00649
Acid mine drainage: A mathematical model.
SMITH, EDWIN E.
UNKNOWN
See Citation No. 72-6TB-0643 p. 3. (1972?)
Languages: ENGLISH

72-07488 72-6TB-00648
Trace element distribution in reactive and inert pyrite.
CARUCCIO, FRANK T.
UNKNOWN
See Citation No. 72-6TB-0643 pp. 2-3. (1972?)
Languages: ENGLISH

72-03470 72-3TB-00252
Evaluation of pyritic oxidation by Mossbauer spectrometry.
BAKER, ROBERT A.
Teledyne Brown Engineering, Huntsville, AL
Water Research. New York, 6(1): 9-17, Jan. 1972 Publ.Yr: 1972
Languages: ENGLISH

72-00531 72-1TB-00004
Acid mine drainage formation and abatement
ANONYMOUS,
Columbus
U.S. Environmental Protection Agency. Water QualityOffice. Wash.,D.C. Water Pollution Control ResearchSeries No. 14010 FPR, 86 pages, April 1971 Publ.Yr: 1971
Languages: ENGLISH

70-06747
The use of inert gas to eliminate acid production by abandoned and active mines
RICE, J. K.
NUS Corp., yrus Wm. Rice Div., Pittsburgh, PA
See Citation No. P70-06735, pp. 169-179, 1970 Publ.Yr: 1970
Languages: ENGLISH

70-06746
Sulfide treatment of coal mine drainage.
STREETER, R. C.
Bitumious Coal Research Inc., Monroeville, PA
See Citation No. P70-06735, pp. 152-168, 1970 Publ.Yr: 1970
Languages: ENGLISH

70-06745
The relation of refuse pile hydrology to acid production.
SHUMATE, K. S.
Ohio State Univ., Water Resources Center, Dept. of CivilEngineering, Columbus
See Citation No. P70-06735, pp. 145-151, 1970 Publ.Yr: 1970
Languages: ENGLISH

70-06742
The quantification of reactive pyrite by grain size.
CARUCCIO, FRANK T.
State Univ. College, Dept. of Geological Sciences, NewPaltz, NY
See Citation No. P70-06735, pp. 123-131, 1970 Publ.Yr: 1970
Languages: ENGLISH

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70-01802
  Sulfide treatment of acid mine drainage.
  BITUMINOUS,COAL RESEARCH
  Monroeville, PA
  U.S. Dept.  of the Interior.  Federal Water PollutionControl
Administration. Wash.,  D.C.  Research Series No.WP Dast-2,  71
pages, Nov. 1969   Publ.Yr: 1969
  Languages: ENGLISH
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J

APPENDIX J

POLLUTION ABSTRACTS DATABASE

SEARCH #2 OF 2

SEARCH STRATEGY:

[ACID AND MINE DRAINAGE]

AND

[PYRIT? OR SULPHIDE OR SULFIDE]

AND

[OXID? AND BACTERIA?]

NOT

[SEARCH #1]

83-00589
Bacterial oxidation of inorganic compounds in mining wastes
Scharer, J.M.; Ibbotson, B.
Univ. Waterloo, Waterloo, Ontario, Canada
Biotech. & Waste Treat. Workshop Univ. Waterloo, Canada
27-31 Jul. 1981
CONSERV. & RECYC VOL. 5, NO. 1, pp. 47-53, Publ.Yr: 1982
SUMMARY LANGUAGE - ENGLISH
Languages: ENGLISH

The environmental consequences of chemolithotrophic bacterial activity in uranium tailings basins in Northern Ontario are examined. Pyrite oxidation by Thiobacillus ferrooxidans and ammonia oxidation by Nitrosomonas have been identified as the major sources of pH depression in the affected lakes in the region. Acidic conditions have adverse effects on fish production. In addition, heavy metal hydroxides are solubilized and occur at elevated concentrations in the lakes receiving discharges from the uranium mining and milling operations.

80-06262
Municipal effluent treatment with hydrogen peroxide.
Anonymous
EFFLUENT & WATER TREATMENT JOURNAL 6-11, Coden: EWTJAG
Publ.Yr: Aug 1979
illus. no refs.
No abs.
Languages: ENGLISH
Doc Type: JOURNAL PAPER

The use of hydrogen peroxide (H_2O_2) in septic sewage and sludge to control H_2S, and in activated sludge processes to provide a source of supplemental O_2, to control bulking, and to overcome denitrification, is described. Direct oxidation by H_2O_2 is relatively fast, usually taking only 15-60 min, depending on the nature of the sewage. Principles involved in the treatment of sulfides in sludges are similar to those for sewage, but due to a higher organic strength than is encountered in sewage, septicity can occur more rapidly in sludge. In practice, between 2 and 5 parts of H_2O_2 are required per part of sulfide in sludge for effective treatment. The phenomenon of bulking is common in activated sludge processing, and is usually due to the formation of filamentous bacteria, which do not settle well in the secondary stage. Treatment with H_2O_2 represents a simple treatment in some cases. It has been successful with Leucothrix, Thiothrix, and Sphaerotilus natans. In conjunction with air, it leads to an effective increase in the capacity of an activated sludge plant, and can increase nitrification. When O_2 starvation at the bottom of the secondary settlement tank leads to denitrification, this can be overcome by adding H_2O_2 at a level of 10-20 mg/L to the base of the tank to act as a source of O_2 preferential to NO_3^-. (FT)

80-06062
Sterilisation and disinfection with peroxygen compounds.
Anonymous
EFFLUENT & WATER TREATMENT JOURNAL 23-28, Coden: EWTJAG
Publ.Yr: Aug 1979
illus. refs.
No abs.
Languages: ENGLISH
Doc Type: JOURNAL PAPER

The use of hydrogen peroxide (H_2O_2) for disinfection of swimming pools improves bacterial kill, controls algal infection, improves water clarity, and can improve sand filtration. Peracetic acid ($C_2H_4O_3$) is used in hospitals. Equilibrated mixtures of H_2O_2 and $C_2H_4O_3$ are currently being used in malthouses to overcome dormancy in barley. Hydrogen peroxide, at dose levels <=700 mg/L, successfully overcomes the blockage caused by algal growth in capillary feed irrigation systems. Bacterial growth, and the accompanying sulfide odor in cutting oils, can be inhibited with H_2O_2. Dioxon-35% w/w H_2O_2 containing an additive-is an efficient slimicide for use in cooling water towers. Other areas where peroxygen compounds may be used as disinfectants include abbattoir and other food processing plants, soil sterilization, and potable water and sewage disinfection for disposal in confined coastal areas. (FT)

80-04940

Mutagenic testing of diethylhydroxylamine, nitroethane, and diethylamine hydrogen sulfite.

Legator, M.; Kouri, R. E.; Parmar, A. S.; Zimmering, S.; Putman, C.; Latt, R.; Heicklen, J.; Meagher, J. F.; Weaver, J. ; Kelly, N.

Univ. of Texas, Medical Branch, Dept. of Preventative Medicine and Community Health, Galveston, TX 77550

ENVIRONMENTAL RESEARCH 20(1), 99-124, Coden: ENVRAL

Publ.Yr: Oct 1979

illus. refs.

Abs.

Languages: ENGLISH

Doc Type: JOURNAL PAPER

Diethylhydroxylamine (DEHA) is an effective inhibitor of photochemical smog formation. The results of mutagenic testing of DEHA, and in some instances also of nitroethane (the new main oxidation product of DEHA) and diethylamine hydrogen sulfide ((C2H5)2NOSO2H), which may be formed from DEHA and SO2 under some circumstances, are reported. Drosophila testing showed less than a 2-fold increase in mutagenic activity by inhalation of DEHA and about a 3-fold increase by feeding. The dominant lethal test on rats injected with DEHA showed significantly increased biological activity only at a dose of 180 mg/kg. For rats treated by inhalation to =10 ppm DEHA and nitroethane, as well as the vapor of (C2H5)NOSO2H, the dominant lethal test showed decreased biological activity. Bacterial testing of urine and the micronuclei test showed some increase in mutagenic activity for rats treated by inhalation. Laboratory tests indicating no increase in mutagenic activity were bacterial testing of DEHA, bacterial testing of the urine of animals fed DEHA, alkylation of hemoglobin and urine of rats treated with DEHA, and micronuclei test of mice fed 200 mg/kg DEHA for 5 d. The only positive test was that for DEHA induction of DNA repair. (AM)

79-05660

Microbial succession and mineral leaching in an artificial coal spoil.

Harrison, A. P., Jr.

Univ. of Missouri, Div. of Biological Sciences, Columbia, MO 65211

APPLIED AND ENVIRONMENTAL MICROBIOLOGY 36(6), 861-869, Coden: AEMIDF Publ.Yr: Dec. 1978

illus. refs.

Abs.

Languages: ENGLISH

Doc Type: JOURNAL PAPER

An artificial pyritic coal spoil was prepared and examined for 1.5 yr for changes in the population of various physiological varieties of bacteria and for mineral leaching. Heterotrophic bacteria were the 1st to dominate the spoil, acquiring a population of 107 cells/g within 2 wk. Bacteria using choline sulfate as the sole source of energy comprised j1% of the total heterotrophic bacteria. Sulfur-oxidizing autotrophic bacteria (Thiobacillus) and finally iron-oxidizing bacteria (Thiobacillus ferrooxidans) increased in the population, the latter becoming the dominant species where acidity was greatest. Partition of species paralleled partition of acidity in the spoil. Maximum acidity (pH 2.6) and maximum population of T. ferrooxidans (K107 cells/g) occurred at the summit. Molds (notably, Aspergillus), algae (Chlorococcales, Oscillatoria, Navicula), cilliated and flagellated protozoa, an arthropod (Podura aquatica), and a moss (aberrant Physcomitrium pyriforme) were observed. The mineral salts leached from the spoil, in decreasing order, were the sulfates of Mg (predominantly hexahydrite), Ca (gypsum), Na, Al (alunogenite), and Fe. (AM)

79-03926

Notes on the condition in September 1978 of some intertidal sands polluted by Amoco Cadiz oil.

Holme, N. A.

Marine Biological Ass'n. of the United Kingdom, The Lab., Citadel Hill, Plymouth PL1 2PB, Devon, Eng.

MARINE POLLUTION BULLETIN 9(11), 302, Coden: MPNBAZ

Publ.Yr: Nov. 1978

no refs.

Abs.

Languages: ENGLISH

Doc Type: JOURNAL PAPER

Brittany beaches heavily polluted with oil from the Amoco Cadiz spill (Ile Grande, Ile a Canton, Saint Michel-en-Greve, and Presqu'ile de Sainte Marguerite) showed a strong development of grey or black layers close to the surface in sands 6 mo after the spill. These sulfide layers indicated reducing conditions, probably caused by bacterial and other oxidative processes, which had acted upon the oil but were now arrested until sediment disturbance or effective flushing could renew the O2. The layers were quite distinct from those attributable to high concentrations of rotting algal material which often occur near rocks. Biodegradation was occurring very slowly where pollution had been heavy or where the sediment was less permeable due to high silt or clay content. It may take many months or years for the sediments to clean. Arenicola and certain other polychaete worms inhabited all but the most heavily polluted stretches of sand. No mollusks or small crustaceans were seen in an incomplete investigation. Recolonization by meiofauna and other infauna may be hindered as much by the reducing conditions as by any continuance of the toxicity of remaining oil. (AM, FT)

79-03867

Controlling corrosive microorganisms in cooling-water systems.

Puckorius, P. R.

P. R. Puckorius & Assoc., Inc., Box 4846, Cleveland, OH 44126

CHEMICAL ENGINEERING 85(23), 171-174, Coden: CHEEA3 Publ.Yr: Oct. 23, 1978

illus. no refs.

Sum.

Languages: ENGLISH

Doc Type: JOURNAL PAPER

Microorganisms found in cooling systems include fungi, algae, and bacteria. Fungi cause slime and wood decay in cooling tower wood and basin walls, and in heat exchangers. Fungal growth can be controlled by periodic applications of fungicides such as pentachlorophenol salts or tributyl tin compounds or by impregnating wood with toxic salts. Although algae do not directly cause corrosion, corrosion can occur under their slime deposits. Reducing sunlight or chemicals such as chlorine, quaternary ammonium compounds and copper salts can control algal growth. Bacteria cause slime, corrosion, gas production, and wood decay; slime formers produce gelatinous substances that can clog heat exchanger tubes and shield metal surfaces from corrosion inhibitors. Iron depositing bacteria convert soluble ferrous iron salts into ferric oxide which causes corrosion. They can be controlled by Cl and nonoxidizing biocides. Sulfate reducing bacteria convert water-soluble sulfur compounds to hydrogen sulfide, which is acidic and can cause pitting on metals. These bacteria are difficult to control but a long chain amine salt as well as other nonoxidizing biocides are effective. Nitrifying bacteria produce nitric acid from atmospheric ammonia or from equipment leaks. Except when appreciable amounts of ammonia are present, Cl is effective against these bacteria. Thiobacillus converts soluble sulfur compounds into sulfuric acid. They can be controlled with Cl. (FT)

78-04543

Consumption of dissolved nitrous oxide in an anoxic basin, Saanich Inlet, British Columbia.

Cohen, Y.

Oregon State Univ., School of Oceanography, Corvallis, OR 97331

NATURE 272(5650), 235-237, Coden: NATUAS Publ.Yr: Mar. 1978

illus. refs.

No abs.

Languages: ENGLISH

Doc Type: JOURNAL PAPER

In Saanich Inlet, a shallow sill at the northern end restricts water exchange with the adjacent Satellite channel causing stagnation of the inlet's deep water in the spring and summer. The inlet is flushed with oxygenated water in later summer and early autumn. During July 1977, when anaerobic conditions, as shown by hydrogen sulfide (H2S) and ammonia accumulation, prevailed in the deep water of the inlet, discrete bottle samples were taken for measurements of nitrous oxide (N2O), O2, H2S, nutrients, temperature, and salinity. The interface layer at about 135-140 m at the 2 sampling stations can be identified from discontinuities in all the chemical variables measured except phosphate. The vertical N2O distributions, similar at the 2 stations, increase gradually from the surface to just above the interface, reaching 17.8 and 20.4 nmol/l at the 2 stations. Between the surface and the N2O maxima, N2O concentrations are inversely related to DO concentrations. Across the interface layer, N2O concentrations decrease drastically, reaching zero in the deep water. This corresponds to a drop from 200% saturation to zero. The N2O, O2, H2S, and nutrient relationships slightly above and within the interface layer indicate biological consumption of N2O. At both stations, the sharp decrease in both the nitrate and N2O concentrations begins in the 10-m interval above the interface. The DO concentration is 10 lmol/l, a range favorable for denitrification, while H2S is absent. The presence of denitrifying bacteria at this depth range was confirmed in experiments carried out at sea a few hours after the N2O measurements were made. These findings represent an extreme case where denitrification completely removes nitrate, nitrite, and dissolved N2O in the water. The presence of low levels of N2O is probably the result of diffusion across the interface. (FT)

78-00117
Bacterial removal of sulfur from coal.
Ford, W. H.; Roffman. H. K.; Beimborn, W. A.
Wyoming Mineral Corp.
COMBUSTION 49(2), 36-38, Coden: ENFIAG Publ.Yr: Aug.
1977
refs.
Sum.
Languages: ENGLISH

The formation of sulfuric acid from S inclusions in coal is a common occurrence in the natural environment, but the reaction rate is almost negligible at room temperature. Bacteria of the Ferrobacillus-Thiobacillus group, however, can appreciably increase the rate of reaction. Bacteria which have been linked to pyrite oxidation are T. thiooxidans and T. ferrooxidans. Although the 2 are morphologically identical, they differ in that the latter can oxidize ferrous ions and thus is the most important bacteria responsible for S removal from coal. The 2 most critical conditions for completion of the reaction are the amounts and proportions of O5 and water available. Other significant factors are temperature, pH, particle size, and crystal structure of the iron disulfide. The increased acidity resulting from bacteriological oxidation of pyrite may be an addad benefit to the possible application of leaching S from coal and may be economically applicable to coals high in leachable metals that can be recovered from the produced leachate. Unfortunately, the maximum conditions under which Thiobacillus-Ferrobacillus bacteria can remove S from coal is not presently known, although the Environmental Systems Department at Westinghouse is beginning a study to determine optimum bacteriological conditions by which S content can be reduced to the point where sulfur dioxide emissions can meet applicable standards.
(from Text)

70-06741
The role of bacteria in pyrite oxidation kinetics.
SMITH, E. E.
Ohio State Univ., Columbus
See Citation No. P70-06735, pp. 114-122, 1970 Publ.Yr:
1970
Languages: ENGLISH

K

APPENDIX K

WATER RESOURCES ABSTRACTS DATABASE

SEARCH #1 OF 1

SEARCH STRATEGY:

[PYRIT? OR SULPHIDE OR SULFIDE]

AND

[THIOBACIL?]

164354 W83-03045
Metabolic Properties of Thiobacillus ferrooxidans Isolated from Neutral pH Mine Drainage
Brown, E. J.; Forshaug, J. M.
Alaska Univ., Fairbanks. Inst. of Water Resources.
Available from the National Technical Information Service, Springfield, VA 22161 as PB83-208306, Price codes: A04 in paper copy, A01 in microfiche. Completion Report 81-11, March 1983. 51 p, 13 Fig, 5 Tab, 82 Ref.,
Journal Announcement: SWRA1609
Thiobacillus ferrooxidans is found in heavy-metal contaminated drainages from placer and lode gold mines in many parts of Alaska and Canada. We have examined the iron-limited growth kinetics of a T. ferrooxidans isolate, AK1, using continuous cultures. AK1 is an arsenic tolerant isolate obtained from placer gold mine drainage containing large amounts of dissolved arsenic. The steady state growth kinetics can be described by a simple Monod equation modified for threshold ferrous iron concentrations. A supplement of 200 mg.1 super -1 reduced a rsenic to the ferrous medium did not result in an increased steady state biomass nor did it appear to affect the steady state growth kinetics obtained in continuous cultures. Kinetic descriptions of the iron-limited growth of acidophilic iron-oxidizing bacteria are important for understanding the biogeochemical cycling of many metals and for application of these microorganisms to biohydrometallurgy.

163825 W83-02592
Oxidation of Iron (II) Salts in Mine Waters Using Bacteria (Eisen (II)-Salz-Oxidation in Grubenwassern Mit Bakterien)
Scholl, U.; Rinder, G.; Beier, E.
Westfaelische Berggewerkschaftskasse, Bochum (Germany, F.R.).
Gas- und Wasserfach: Wasser/Abwasser, Vol 122, No 4, p 163-168, April, 1981. 5 Fig, 11 Ref.,
Journal Announcement: SWRA1608
Iron oxidation by Thiobacillus ferrooxidans was investigated in discontinuous and continuous cultures with different packing material (quartz, tuffstone). In preliminary batch tests as many bacteria as possible should be adsorbed on the packing material. It was shown that in cultures with packing material, the oxidation rate was higher than in cultures without packing material. Therefore continuous experiments were conducted only with packing material. Upon using a nutrient-poor, phosphate-free culture medium instead of a nutrient-rich culture medium, the oxidation rate was not lowered. When the concentration of ferrous iron in the feed solution and the feed rate were increased, a corresponding increase in the oxidation rate was noted. At an oxidation rate of 475 mg/1-h(Fe2+) and a concentration drop of ferrous iron from 715 to 1.7 mg/1, the retention time of the solution in the reaction tube was 1.5 hr. There was not much difference in oxidation rate in cultures with different packing materials. In continuous cultures 75% of the formed ferric iron remained in solution at pH 2.5. (Baker-FRC)

163520 W83-02290
Biogeochemistry of Arsenic Mine Drainage
Luong, H. V.; Forshaug, J. M.; Brown, E. J.
Alaska Univ., Fairbanks. Inst. of Water Resources.
Available from the National Technical Information Service, Springfield, VA 22161 as PB83-180273, Price codes: A02 in paper copy, A01 in microfiche. Completion Report 79-21, November 1981. 20 p, 1 Fig, 2 Tab, 6 Ref. 1 Append. OWRT B-045-ALAS(1), 14-34-0001-0202.,
Journal Announcement: SWRA1607
Arsenic is enriched in gold and sulfide deposits throughout many areas of Alaska. Consequently, some stream waters, stream sediments and groundwaters contain dissolved arsenic concentrations in excess of the Environmental Protection Agency's recommended limit of 50 parts per billion (pbb: Wilson and Hawkins, 1978) We report here that the acidiophile, T. ferrooxidans is present in most neutral pH subarctic streams affected by gold mining activities. Some of these streams have measurable levels of dissolved arsenic while others do not. We also report that the presence of T. ferrooxidans increases the rate that arsenic leaches from gold-bearing material at least fourfold over the abiotic leaching rate. In summary, we have found that high numbers of acidophilic bacteria exist in mine drainage that contains arsenic. This provides indirect evidence that microbial activity is associated with increased levels of arsenic in streams and groundwaters. Heavy metal leaching may yet prove to be from localized pyritic material via the conventional 'acid-mine drainage' mechanisms, via some as yet undiscovered biochemical mechanism, or even via a strict chemical equilibrium process in the presence of incidental populations of T. ferrooxidans. Whatever the mechanism of heavy metal leaching in the areas described, mining activity continues to increase. We feel, therefore, that studies of the biogeochemistry of those areas should continue.

DIALOG INFORMATION SERVICES, INC.

180481 W82-06542

Determination of the Number of Respiring Thiobacillus Ferrooxidans Cells in Water Samples by Using Combined Fluorescent Antibody-2-(p-Iodophenyl)-3-(p-Nitrophenyl)-5-Phenyltetrazolium Chloride Staining

Baker, K. H.; Mills, A. L.

Virginia Univ., Charlottesville. Dept. of Environmental Sciences.

Applied and Environmental Microbiology, Vol 43, No 2, p 338-344, February, 1982. 2 Fig, 2 Tab, 40 Ref..

Journal Announcement: SWRA1512

Direct counting of microbial cells stained with fluorescent dyes is a commonly used method for determining the total standing crop of microorganisms in natural habitats, but it cannot differentiate specific types of bacteria nor distinguish between live and dead cells. The reduction of 2-(p-iodophenyl)-3-(p-nitrophenyl)-5-phenyltetrazolium chloride (INT) to extractable formazan has been shown to be correlated with oxygen uptake and respiratory activity. A simple method has been developed for combining fluorescent antibody staining and INT reduction to determine the numbers of viable Thiobacillus ferrooxidans cells in aquatic habitats. The procedure, called FAINT, provides a rapid, accurate measure of species-specific numbers of active cells and is more sensitive than conventional cultural techniques by at least one order of magnitude. The technique was used to investigate the distribution of T. ferrooxidans in both acidic and nonacidic sites. Comparisons among the FAINT technique and fluorescent antibody staining alone or most-probable-number determinations in 9K broth showed that the use of most-probable-number techniques resulted in an underestimation of the number of viable cells by one to three orders of magnitude, while the fluorescent antibody counts resulted in overestimation of the number of viable cells. The amount of difference varied with the sample site. (Carroll-FRC)

180963 W81-03329

Environmental Effects of Western Coal Surface Mining; Part VII - Microbial Effect on the Quality of Leach Water from Eastern Montana Coal Mine Spoils

Kimble, P. F.; Temple, K. L.

Montana State Univ., Bozeman. Dept. of Microbiology.

Available from the National Technical Information Service, Springfield, VA 22161 as PB80-198245, Price codes: A05 in paper copy, A01 in microfiche. Environmental Protection Agency Report, EPA-600/3-80-046, May, 1980. 89 p, 5 Fig, 29 Tab, 50 Ref. R803950..

Journal Announcement: SWRA1416

Selected portions of test cores from the overburden of the West Moorhead coal deposit in southeastern Montana were examined for possible addition to leach water of toxic substances and for the presence of iron and sulfur bacteria which might contribute to leaching. Leachates were evaluated by measuring pH, lead, and the effect of the leachates on the Selenastrum algal assay. Both sulfur- and iron-oxidizing bacteria were isolated from a number of core samples. These bacteria differed nutritionally from thiobacilli and from other bacteria known to be involved in oxidizing sulfur and iron. Concentrations of lead in the leachates were comparable; they were not proportional to the lead content of the core samples. Most core samples were nearly neutral in reaction but some were highly acid. All acid leachates were toxic to Selenastrum. For reasons which were not determined, some non-acid leachates were also toxic to Selenastrum and some leachates stimulated Selenastrum growth. It is concluded that acid formation in overburden spoils would be a problem only when a potentially acid-forming stratum is so placed during spoil reclamation that it drains directly into a surface stream. It is recommended that laboratory bioassays be used adjunct to chemical analysis for identifying problem strata.

138930 W79-06823

The Immobilization of Nitrogen in a Water-Sediment System by Denitrifying Bacteria as a Result of Nitrate Respiration

Van Kessel, J. F.

Agricultural Univ., Wageningen (Netherlands). Dept. of Microbiology.

Progress in Water Technology, Vol. 8, No. 4-5, p 155-160, 1977. 4 tab, 8 ref.,

Journal Announcement: SWRA1218

A laboratory study of the immobilization of nitrate- and ammonium-nitrogen in surface water by denitrifying bacteria in sediments shows that most nitrate added to the water-sediment samples (95-97%) was removed by volatilization due to denitrification. Sediment samples were collected from two ditches, one carrying effluent from a purification plant for liquid animal manure and containing 3.36% organic matter dry wt (Sediment A), and one draining arable land and containing 1.37% organic matter (Sediment B). Twenty-ml solutions containing different amounts of ammonium chloride or sodium nitrate were added to 20-g sediment samples. The nitrate added to the tubes was consumed after 42 days of incubation for Sediment A and 25 days for Sediment B. Immobilization of labelled ammonium during the incubation periods is increased by the presence of nitrate, which functions as hydrogen acceptor. For Sediment A samples, 97.2% of added nitrate was lost due to denitrification, and for Sediment B sampes, 94.5%; the remaining part was converted into organic matter and ammonia. The quantity of immobilized ammonium nitrogen derived from Sediment A is equal to 7.3% when calculated on the added nitrate nitrogen, and from Sediment B 4.1%. Total nitrogen (nitrate- and ammonium-nitrogen) immobilized due to the addition of nitrate is about 10% of the nitrate-nitrogen added for both sediments. Interaction of water and sediment is a natural and cheap method of removing nitrate from shallow surface waters. (Lynch-Wisconsin)

137759 W79-07651

Bacterial Streamer Growth in a Disused Pyrite Mine

Johnson, D. B.; Kelso, W. I.; Jenkins, D. A.

University Coll. of North Wales, Bangor. Dept. of Biochemistry and Soil Science.

Environmental Pollution, Vol. 18, p 107-118, 1979. 5 fig, 3 tab, 22 ref..

Journal Announcement: SWRA1216

A disused pyrite mine in the Conwy Valley, North Wales, was found to contain copious amounts of 'acid streamer' of heterotrophic bacterial origin. The geology of the mine is discussed and analytical data on the acid stream which flows through the mine are presented. The UV and visible spectra of the typically orange/red-coloured water were investigated and the main ionic species responsible for the colour identified as being Fe(OH)2(+), Fe(SO4)2(-), Fe(SO4)(+). The local pollution caused by the acid discharge is mentioned. (Deal-EIS)

133211 W79-03104

Bacterial Ecology of Strip Mine Areas and its Relationship to the Production of Acidic Mine Drainage

Dugan, P. R.

Ohio State Univ., Columbus. Dept. of Microbiology.

The Ohio Journal of Science, Vol. 75, No. 6, p. 266-279, November 1975. 12 fig, 1 tab, 50 ref. OWRT A-001-OHIO(2)..

Journal Announcement: SWRA1207

The activity of acidophilic bacteria as agents involved in the production of sulfuric acid from iron pyrite (FeS2) found in association with coal mine refuse or spoils was reveiwed. Data were presented which demonstrated the inhibitory effect of anionic detergents and certain organic acids on the growth and metabolism of the acidophilic thiobacilli. The influence of acidic mine drainage on the microflora of non-acid polluted streams was considered. Also discussed were the heterotrophic microbes which are indigenous to acid (pH 3.0) streams and acid coal refuse, with a section devoted to the potential for sulfate reducting bacteria as agents for removal of sulfuric acid from the streams. (Chao-Ohio).

128999 W78-11852

Autotrophic Denitrification Using Elemental Sulfur

Batchelor, B.; Lawrence, A. W.

Texas A and M Univ., College Station. Dept. of Civil Engineering.

Journal Water Pollution Control Federation Vol 50, No 8, p 1986-2001, August, 1978. 9 fig, 8 tab, 24 ref, 1 append..

Journal Announcement: SWRA1123

The kinetic, stoichiometric, and solids separation properties of an autotrophic denitrification process employing Thiobacillus denitrificans were evaluated in five continuous-culture, anaerobic slurry reactors using elemental sulfur. Steady-state stoichiometric reactions and nitrate removal were calculated for various solids retention time; the maximum denitrification rate was then determined for ratios of elemental sulfur to biomass ranging over 45-194 mg/mg nitrate-nitrogen. A series of zone settling velocity and flocculant settling tests were conducted at several elemental sulfur concentrations. The observed biomass yield remained fairly constant within a range of growth rates, elemental sulfur-to-biomass values, and temperatures, indicating negligible microbial decay; a stoichiometric equation for autotrophic denitrification was derived from the average observed biomass yield and an empirical cell mass formula. Under steady-state conditions, the continuous flow reactors achieved about 99.5% nitrate removal. The maximum unit rate of denitrification was a linear function of the sulfur-to-biomass concentration ratio; the influence of temperature was described by the Arrhenius equation. Within the lower ranges of sulfur-to-biomass, smaller solid fluxes were produced; the solids flux was linearly related to the sulfur-biomass slurry solids level. The effluent suspended solids concentration was proportional to the overflow rate. (Lisk-FIRL)

128905 W78-11798

Answering Mecca's Sewerage Prayers

World Water, Vol. 1, No. 1, p 42-43, 45, May, 1978..

Journal Announcement: SWRA1123

Sewage treatment facilities and sewer systems in Mecca, Saudi Arabia, must accommodate flows during pilgrimate periods that are double the normal flows. The English engineering consulting firm of J. D. and D. M. Watson has designed and supervised the construction of 65 km of trunk sewers, up to 1.02m in diameter, and 200 km of smaller sewers. To prevent corrosion of sewer pipes by thiobacillus concretivorus, the sewers have been installed with adequate gradients to prevent siltation and septicity; the trunk pipes are constructed of clayware and the minor sewers are asbestos cement lined with epoxy to resist sulfide corrosion. Periodic floods are controlled by a network of trapezoidal concrete-lined and channels surrounding the city to divert surface runoff from flowing into the dry river beds that comprise the city's main streets. One network of channels is 2 m deep, 2 m wide at the base, and 10 m wide at the top; the other network has channels with depths of 2.5 m and a bottom-to-top width range of 1.5-6.5 m. The only operational sewage treatment plant employs primary treatment, filter beds, humus tanks, primary digestion tanks, and sludge drying beds. Treated effluent may eventually irrigated green belts around the city; effluent is currently discharged into the dry river beds. The Watson engineering firm also supplied the designs for upgrading Mecca's 9th century vintage aqueduct water supply system. (Lisk-FIRL)

128140 W78-11036

Sulfur Oxidation and Respiration in 54-Year-Old Soil Samples

Bollen, W. B.

Pacific Northwest Forest and Range Experiment Station, Corvallis, OR. Forestry Sciences Lab.

Soil Biology and Biochemistry, Vol 9, No 6, p 405-410, 1977. 3 tab, 16 ref.,

Journal Announcement: SWRA1122

Soil samples in dry storage for 54-yr retain their ability to respire and to oxidize S. Three of the soils had lower S-oxidizing capacity and three oxidized more S at 1 g kg-1 than did the samples when originally collected. When the experiment was repeated with all apparatus sterilized by autoclaving and sterilized in flowing steam, a greater proportion of the S was oxidized. This was not due to heat treatment of the S. In all cases, S additions and incubation resulted in a lowering of the soil pH, suggesting that Thiobacillus thiooxidans was responsible and had survived the prolonged storage. When the soils, before and after incubation, were added to Thiobacillus media, only Gram-positive bacteria, mostly Bacillus spp., were found. (Skogerboe-Colorado State)

125994 W78-08885

Mediation of Acid Strip Mine Pollution by the Attempted Inhibition of the Iron-Oxidizing Autotroph, Thiobacillus Ferrooxidans

Kugatow, M. A.

Pennsylvania State Univ., University Park.

Available from University Microfilms International, Ann Arbor, MI 48106; Order No. 7803339. PhD Thesis, 1977. 68 p.,

Journal Announcement: SWRA1119

The growth of autotrophic Thiobacillus ferrooxidans, sulfur-oxidizing bacteria, and heterotrophic microorganisms in strip-mined acid soils and in laboratory test soil was studied under varying conditions of pH, chemical treatment, and detergent inhibitors. Soils with low pH values contained high concentrations of the iron-oxidizing bacteria; partial neutralization of the acid solids reduced the iron-oxidizing bacterial population. Sulfur oxidizing bacterial growth was not related to pH, although partial neutralization of the soils with Ca(OH)2 stimulated microogranism growth in some instances. Dodecylbenzenesulfonate detergent applied to the soils decreased the population of iron-oxidizing bacteria for 2-6 weeks except in highly acidic soils; sulfur-oxidizing bacterial numbers fluctuated but were not significantly affected by the detergent. Laboratory soil tests verified the data from on-site investigations; detergent hindered the growth of Thiobacillus ferrooxidans and prevented the reacidification of some partically neutralized mine soils. The inhibitors utilized in these tests did not change pH or total acidity of the acid mine soils. (Lisk-FIRL)

Denitrification Using Thiosulfate and Sulfide

Bisogni, J. J. Jr; Driscoll, C. T. Jr

Cornell Univ., Ithaca, NY. Dept. of Environmental Engineering.

Journal of the Environmental Engineering Division, Proceedings of the American Society of Civil Engineers, Vol. 103, No. EE4, p 593-604, August 1977. 3 fig, 6 tab, 10 ref.,

Journal Announcement: SWRA1118

Autotropic denitrification using enriched cultures of Thiobacillus denitrificans was investigated. Thiosulfate and sulfide were used as electron donors in laboratory scale denitrification systems. The stoichiometric ratio of the amount of sulfur electron source (sulfide or thiosulfate) needed to reduce a given amount of nitrate was determined. This ratio (called the consumptive ratio, Cr) is concluded to be approximately 1.35 on an electron equivalent basis. The systems were tested under dynamic loading conditions to assess overall operational stability. In all experiments, denitrification proceeded efficiently. It is concluded that autotropic denitrification using sulfide or thiosulfate has potential as a wastewater treatment process. (Graf-Cornell)

123257 W78-06146

The Treatability of Leachates from Sanitary Landfills

Buchanan, R. J. Jr

Drexel Univ., Philadelphia, PA. Coll. of Business Administration.

Available from University Microfilm International, Ann Arbor, Michigan 48106; Order No. 77-22,526. PhD Thesis, 1977. 255 p.,

Journal Announcement: SWRA1113

Physicochemical and biological treatment processes applicable to leachates from sanitary landfills were investigated in bench-scale and full-scale experiments. Laboratory experiments examined the effects of precipitants, coagulants, activated carbon, low pH biological treatment, and conventional activated sludge processes on landfill leachates. Treatment with the ferrous oxidizing bacterium, Thiobacillus ferrooxidans, in the low pH treatment scheme was demonstrated as feasible for leachates. (Schulz-FIRL)

125410 W78-08301

119021 W78-01912

A New Type of Thiosulphate Oxidizing, Nitrate Reducing Microorganism: The Omicrospira Dentrificans Sp. Nov.

Timmer-Ten Hoor, A.

Nederlands Inst. voor Onderzoek der Zee, Texel.

Netherlands Journal of Sea Research, Vol. 9, No. 3-4, p. 344-350, December 1975. 2 fig, 8 ref.,

Journal Announcement: SWRA1105

Thiomicrospira denitrificans, a new species of thiosulphate-oxidizing, nitrate-reducing microorganisms, was isolated from a mixture of brown and black mud from tidal flats of the Dutch Wadden Sea in an anaerobic chemostat enrichment culture. The isolation of thiomicrospira was a byproduct of an effort to obtain a culture of Thiobacillus denitrificans. Thiomicrospira denitrificans is spiral-shaped, brown-colored in colonies, not motile, and is variable in length. Cells are 0.3 microns thick. It appears to be an obligate anaerobe, as well as an obligate denitrifier; this latter fact is peculiar since previously isolated nitrate-reducing organisms are normally regarded as facultatively aerobic. Although the microorganism has been isolated only once so far, future isolations should be relatively easy, as long as care is taken to ensure the complete removal of oxygen from the enrichment culture. (Lynch-Wisconsin)

116345 W77-12250

Analysis of Heavy Metals and Bacteria in Sediments from Danish Lignite Pits

Fjerdingstad, E.; Fjerdinstad, E.; Popea, F.

Copenhagen Univ. (Denmark). Inst. of Hygiene.

Archiv fur Hydrobiologie, Vol 77, No 2, p 226-253, 1976. 6 fig, 8 tab, 40 ref.,

Journal Announcement: SWRA1023

Samples of sediment were drawn from some old, open lignite pits and investigated with a view to establishing the occurrence of trace elements. Iron constituted about 50% of the dry weight of these samples. Extensive investigations of the occurrence of acid thiobacilli were likewise made. With the only exception of T. ferro-oxidans, the species were determined on the basis of the pH-value after 28 days of incubation. There was found to be a great disparity in number as regards bacteria cultivated in sulfur medium and bacteria cultivated in thiosulfate medium. A reason for this might be that heavy metal sulfides were sparingly soluble in a sulfur medium whereas the complexes formed in the thiosulfate medium are more easily soluble. (Klein)

114645 W77-10548

Sewers Under Attack: The Hydrogen Sulphide Problem

Pullin, J.

Surveyor, Vol. 149, No. 4433, p 12, May 27, 1977.,

Journal Announcement: SWRA1021

Hydrogen sulfide can be produced in sewage under anaerobic conditions by the reduction of sulfate, or in sewers containing dissolved oxygen but having a layer of biological slime coating the sewer pipe wall. The hydrogen can be then oxidized in the presence of Thiobacillus concretivorus to sulfuric acid which can cause considerable damage to sewer pipes. Factors influencing the rate of H2S build-up include oxygen concentration, temperature, and concentrations of sulfate and organic matter in the sewage. Increased temperatures and decreased oxygen concentrations increase sulfide production. The resistance of various pipe materials to attack by sulfuric acid is examined. Although vitrified clay pipes are resistant to corrosion, cast iron, steel, and concrete pipes will deteriorate unless other preventive measures are taken. Use of plastic liners for sewer pipes, periodic treatment with caustic soda or lime, and application of chlorine are suggested as methods for reducing corrosion. (Schulz-FIRL)

108177 W77-04077

Microbiological and Chemical Study of Water in the Baia de Aries Mine, (In Romanian)

Lazar, I.; Grou, E.; Dumitru, L.; Popea, F.

Societatea de Stiinte Biologice din R.S.R., Bucharest.

Stud Cercet Biol 26(3), p 197-203, 1974.,

Journal Announcement: SWRA1008

Research conducted at the Baia de Aries (Romania) mine in the course of the last 2 yr made it possible to conclude that chemoautotrophic bacteria of the Thiobacillus genus, which oxidate the reduced compounds of S and Fe, are very widespread in the water samples gathered from various levels in the mine. It was demonstrated through chemical and microbiological analyses that, during the passage of water through the deposit rock (consisting principally in sulfides), some processes take place which determine the formation of important quantities of sulfuric acid and Fe salts as a result of the activity of Thiobacillus type bacteria. The biological activity is gradually increased towards the lower levels, reaching a maximum at level 0.--Copyright 1976, Biological Abstracts, Inc.

104678 W77-00681

Evaluation of a Sulfur-Thiobacillus Denitrificans Nitrate Removal System

Sikora, L. J.; Keeney, D. R.

Agricultural Research Service, Beltsville, Md.

Journal of Environmental Quality, Vol. 5, No. 3, p 298-303, July-September, 1976. 6 fig, 3 tab, 32 ref.,

Journal Announcement: SWRA1002

A sulfur-Thiobacillus denitrificans nitrate removal system was evaluated as a means of denitrifying nitrified septic tank effluent. Duplicate 10 by 64 cm columns were filled with a 1/1 mixture (by weight) of elemental sulfur and dolomite chips and were pretreated by recycling an enrichment culture of Thiobacillus denitrificans ATCC 23642 through the columns for 3 days. Continuous passage of the nitrified septic tank effluent containing 40 micrograms of nitrate/milliliter through the columns resulted in nearly complete nitrate removal in 3.3 hours at steady state conditions. The denitrification kinetics appeared to be first order in the range of nitrate concentrations used. Sulfate was the major sulfur end product and was present at relatively high concentrations (90 micrograms/milliliter). Passage of column effluent through 10 by 60 cm Plainfield sand columns did not significantly decrease sulfate levels. A significant decrease in inorganic carbon content occurred with depth in the columns, but changes in organic carbon were insignificant. Although the use of this nitrate removal system appears promising, sulfate contamination of the groundwater may limit its applicability. (Kreager-FIRL)

101941 W76-11541

REMOVAL OF HYDROGEN SULFIDE FROM DRINKING AND INDUSTRIAL WATER, (IN RUSSIAN)

ASS, G. Y.; BAKHAREVSKAYA, O. S.; KLYACHKO, V. A.; LAZAREVA, M. F.; LEVENTON, O. L.

VSESOYUZNYI NAUCHNO-ISSLEDOVATELSKII INSTITUT VODOSNABZHENIYA, KANALIZATSII, GIDROTEKHNICHESKIKH SOORUZHENII I INZHENERNOI GIDROGEOLOGII, MOSCOW (USSR).

GIG SANIT. 38(8), P 87-88, 1973.,

Journal Announcement: SWRA0921

AN EXPERIMENTAL DEVICE IS DESCRIBED FOR REMOVING H2S FROM WATER WHICH CONSISTED OF A 350-1 VESSEL WITH A DIAMETER OF 0.67 M AND HEIGHT OF 1 M WHICH WAS FILLED WITH A 0.5-M-HIGH LAYER OF RUBBLE. THE WATER FROM AN ARTESIAN WELL PASSED THROUGH A WATER-JET PUMP FOR ENRICHMENT WITH ATMOSPHERIC O2 AND WAS DELIVERED TO THE RUBBLE THROUGH A 12-MM-DIAMETER PERFORATED PIPE WITH FOUR 3-MM-DIAMETER HOLES SPACED 16.5 MM APART WHICH WAS LAID ON THE BOTTOM OF THE VESSEL. BETWEEN 90 AND 95% OF THE H2S WAS REMOVED FROM THE WATER DURING THE 30-60 MIN STAY OF THE WATER IN THE DEVICE WITH AN AIR DELIVERY RATE OF 3-5 M3/M3 OF WATER. THE PRESENCE OF A LARGE NUMBER OF THIOBACILLUS THIOPARUS IN THE BIOFILM OF THE DEVICE INDICATED THAT OXIDATION OF H2S OCCURRED BIOLOGICALLY.--COPYRIGHT 1975, BIOLOGICAL ABSTRACTS, INC.

100344 W76-09814

CHARACTERISTICS OF THIONIC BACTERIA FROM THE LAKES OF THE MARI ASSR, (IN RUSSIAN)

VAINSHTEIN, M. B.

MIKROBIOLOGIYA. 44(1), P 151-155, 1975.,

Journal Announcement: SWRA0918

FIVE KARST LAKES WERE INVESTIGATED IN THE MARI ASSR (RUSSIAN SFSR, USSR). THE VERTICAL DISTRIBUTION OF SULFUR BACTERIA IN WATER WAS CORRELATED TO THE DISTRIBUTION AND CONTENT OF DISSOLVED SULFIDES. THE CONCENTRATION OF SULFUR BACTERIA WAS HIGHER IN MORE PRODUCTIVE LAKES. A SYMBIOTIC CULTURE OF SULFUR AND DENITRIFYING BACTERIA (NOT THIOBACILLUS DENITRIFICANS) WAS ISOLATED FROM THESE LAKES.--COPYRIGHT 1975, BIOLOGICAL ABSTRACTS, INC.

100248 W76-09712

MICROBIAL ASPECTS OF CARBONISATION EFFLUENT TREATMENT

STAFFORD, D. A.

UNIVERSITY COLL., CARDIFF (WALES). DEPT. OF MICROBIOLOGY.

EFFLUENT AND WATER TREATMENT JOURNAL, VOL. 16, NO. 3, P 136-137, 139, MARCH, 1976. 20 REF.,

Journal Announcement: SWRA0918

MICROORGANISMS CAN READILY UTILIZE COMPOUNDS FROM CARBONIZATION LIQUORS AS ENERGY AND CARBON SOURCES. CARBONIZATION LIQUORS ALSO PROVIDE ELEMENTAL SOURCES FOR BIOSYNTHESIS. DUE TO THEIR BIOCHEMICAL POTENTIAL, MICROORGANISMS ARE IDEALLY SUITED FOR THE CHEMICAL TRANSFORMATIONS NECESSARY TO MINERALIZE THE ORGANIC AND INORGANIC COMPOUNDS OF CARBONIZATION LIQUORS. THE PREDOMINANT BACTERIA IN THE ACTIVATED SLUDGE TREATMENT OF CARBONIZATION LIQUORS INCLUDE PSEUDOMONADS AND THIOBACILLI; PSEUDOMONADS ARE INVOLVED IN THE BREAKDOWN OF ORGANICS, AND REDUCED SULFUR COMPOUNDS ARE ATTACKED MAINLY BY THIOBACILLI. THE HETEROTROPHIC ORGANISMS OBTAINING CARBON AND ENERGY FROM THE AROMATIC AND HETEROCYCLIC COMPOUNDS OF WASTE LIQUORS ARE CLOSELY ASSOCIATED WITH THOSE DERIVING ENERGY FROM OTHER PROCESSES. SOME OF THE CONSTITUENTS IN THE EFFLUENTS CAN AFFECT THE METABOLISM OF SOME OF THESE MICROORGANISMS. THE PRODUCTS OF REACTIONS CARRIED OUT BY THE MICROORGANISMS INCLUDE SUBSTANCES NECESSARY FOR THEIR GROWTH. BACTERIA MAY ACT ON SOME COMPOUNDS PREFERENTIALLY; METABOLIC INTERMEDIATES ARE OFTEN USED PREFERENTIALLY TO THE ORIGINAL COMPOUNDS. ADDING CERTAIN ORGANIC COMPOUNDS TO THE LIQUOR FEED INCREASED THE BIOCHEMICAL OXIDATION RATE BY AS MUCH AS THREE TIMES. THE COMPOUNDS ALSO OFTEN IMPROVE EFFLUENT QUALITY. STUDIES INDICATE THAT BACTERIA PROBABLY DO NOT PLAY A ROLE IN REMOVING LIQUOR COMPONENTS IN WASTE-TIP LAGOON SYSTEMS. (SNYDER-FIRL)

100133 W76-09592

STUDIES ON THE METABOLISM OF A SULFUR-OXIDIZING BACTERIUM. VII. PURIFICATION AND CHARACTERIZATION OF SOLUBLE COMPONENTS INDISPENSABLES FOR SULFUR OXIDATION BY THIOBACILLUS THIOOXIDANS

TAKAKUWA, S.

NAGOYA UNIV. (JAPAN). BIOLOGICAL INST.

PLANT AND CELL PHYSIOLOGY, VOL. 16, NO. 6, P. 1027-1035, 1975. 4 FIG., 3 TAB., 20 REF.,

Journal Announcement: SWRA0916

TO UNDERSTAND THE SULFUR OXIDATION MECHANISM IN THIOBACILLUS THIOOXIDANS, THE NATURE OF A COLLODION MEMBRANE-IMPERMEABLE SOLUBLE FRACTION WAS STUDIED. THIS FRACTION WAS REQUIRED FOR THE SULFUR-OXIDIZING SYSTEM OF THIOBACILLUS. IT WAS RESOLVED INTO TWO COMPONENTS BY AMMONIUM SULFATE FRACTIONATION, AMBERLITE CG-50 AND DEAE CELLULOSE COLUMN CHROMATOGRAPHY, AND SEPHADEX GEL FILTRATION. BOTH COMPONENTS WERE NEEDED FOR SULFUR OXIDATION. THE FIRST COMPONENT HAD A MOLECULAR WEIGHT OF 120,000 AND WAS A NON-HEME IRON PROTEIN. THE ABSORPTION MAXIMUM OF THE OXIDIZED FORM WAS 410 NM BUT REDUCTION SHIFTED IT TO 420 NM. THE SECOND COMPONENT WAS A NEW FLAVOPROTEIN CONTAINING NON-HEME IRON. IT ALSO SHOWED AN ABSORPTION CHANGE AT 410 NM, BUT THERE WAS A SHOULDER AT 485 NM IN THE OXIDIZED FORM WHICH DISAPPEARED ON REDUCTION. ITS MOLECULAR WEIGHT WAS 23,000 BY GEL FILTRATION. METAL-CHELATING AGENTS LIKE EDTA, SODIUM DIETHYL DITHIOCARBAMATE, AND O-PHENATHROLINE INHIBITED THE RECONSTITUTED SYSTEM'S SULFUR-OXIDIZING ACTIVITY. SEVERAL NUCLEOTIDES, WHICH ARE KNOWN FLAVOPROTEIN INHIBITORS, INHIBITED THE SULFUR-OXIDIZING ACTIVITY. REMOVAL OF IRON FROM SOLUBLE FRACTION COMPONENTS WITH POTASSIUM CYANIDE OR SODIUM DIETHYL DITHIOCARBAMALE DECREASED THE RECONSTITUTED SYSTEM'S SULFUR-OXIDIZING ACTIVITY. THE IRON AND FLAVIN IN THE SOLUBLE COMPONENTS MAY PLAY AN IMPORTANT ROLE IN THE ELEMENTAL IRON-OXIDIZING SYSTEM OF THIS ORGANISM. (BUCHANAN-DAVIDSON--WISCONSIN).

080874 W75-02556

FOOL'S GOLD POLLUTES

ASTON, W. M.

WEST VIRGINIA UNIV., MORGANTOWN.

CANADIAN MINING JOURNAL, VOL 95, NO 3, P 59-61, MARCH, 1974.

Journal Announcement: SWRA0805

ONE OF THE MOST SEVERE WATER POLLUTION PROBLEMS FACING WEST VIRGINIA, APPALACHIA, AND OTHER COAL OR BASE METAL MINING AREAS IS ACID MINE DRAINAGE. THE CAUSES OF THIS POLLUTION SOURCE ARE EXPLAINED AND THE SCOPE OF THE PROBLEM DISCUSSED. ABATEMENT TECHNIQUES SUCH AS NEUTRALIZATION AND REVERSE OSMOSIS ARE DESCRIBED. (SANDOSKI-FIRL)

077348 W74-12949

MICROBIOLOGICAL PURIFICATION OF HYDROGEN SULFIDE CONTAINING WASTE WATERS FROM SULFATE PULP PRODUCTION (MIKROBIOLOGICHESKAYA OCHISTKA SEROVODORODNYKH STOCHNYKH VOD SULFATNOTSELLYULOZNOGO PROIZVODSTVA)

TKACHENKO, N. I.; POMERANTS, L. B.

PRIKLADNAYA BIOKHIMIYA I MIKROBIOLOGIYA, VOL 8, NO 5, P 569-573, 1972. 2 FIG, 1 TAB, 18 REF. (ENGLISH SUMMARY).,

Journal Announcement: SWRA0724

IN CONTINUATION OF EARLIER STUDIES ON THE REMOVAL OF HYDROGEN SULFIDE FROM DIGESTER EXHAUST CONDENSATES AND OTHER KRAFT MILL WASTE WATERS, LABORATORY EXPERIMENTS WERE CONDUCTED ON THE EFFECTS OF BIOLOGICAL FILTERS ON MODEL EFFLUENTS CONTAINING SODIUM SULFIDE AND AMMONIUM SULFATE AS NITROGEN SOURCE. SAMPLES WERE ANALYZED FOR MICROFLORAL COMPOSITION, REDOX POTENTIAL, PH, RH, AND S COMPOUNDS BEFORE AND AFTER PASSAGE THROUGH THE FILTER. AN INITIAL INCREASE IN COUNTS OF SAPROPHYTIC BACTERIA AND THIOBACILLUS THIOPARUS DURING FILTER FORMATION WAS ACCOMPANIED BY DRASTIC REDUCTION IN HYDROGEN SULFIDE AND INCREASED SULFATE CONTENTS. THE TH. THIOPARUS COUNT REACHED A MAXIMUM AFTER ABOUT ONE MONTH, BUT OTHER SULFUR BACTERIA (SUCH AS TH. THIOOXIDANS AND SULFUR-REDUCING BACTERIA) WERE ABSENT AT PH ABOVE 7.6. SINCE ELEMENTARY SULFUR WAS RETAINED ON THE FILTER SLAG, NO S WAS CONTAINED IN THE PURIFIED EFFLUENT DURING THE FILTER-FORMING STAGE. LATER, THE BACTERIAL FILM WAS MECHANICALLY WASHED AWAY, ALONG WITH ELEMENTARY S, SO THAT THE LATTER COULD BE RECOVERED AND RECYCLED TO THE COOKING LIQUOR PREPARATION STAGE. A SULFUR MATERIAL BALANCE FOR 80 DAYS OF BIOLOGICAL FILTRATION IS TABULATED. (STAPINSKI-IPC)

075407 W74-10796

SOME CHARACTERISTIC FEATURES OF THE BACTERIAL DECOMPOSITION IN SEDIMENTS FROM LAKES AND PONDS IN SOUTHWEST GREENLAND (THE NARSSAQ AREA)

FJERDINGSTAD, E.; BERG, O.

COPENHAGEN UNIV. (DENMARK). INST. OF HYGIENE.

ARCHIV FUR HYDROBIOLOGIE, VOL 72, NO 3, P 313-332, 1973. 7 FIG, 4 TAB, 40 REF.,

Journal Announcement: SWRA0720

THE WEST GREENLAND LAKES, WHERE THE INFLUENCE OF CIVILIZATION IS MINIMAL, WERE INVESTIGATED. SEVENTEEN SAMPLES OF SEDIMENT FROM LAKES AND PONDS IN THE NARSSAQ AREA WERE EXAMINED BACTERIOLOGICALLY, ESPECIALLY WITH A VIEW TO ESTIMATE CELLULOSE DECOMPOSITION AND SULFUR OXIDATION. THE INVESTIGATED AREA IS SITUATED ON OLD GEOLOGICAL FORMATIONS. SOME PRINCIPAL FEATURES OF THE CLIMATIC CONDITIONS ARE GIVEN. ON THE BASIS OF EXAMINATIONS OF MUD FROM THE RIVER TIDAL, IT HAD BEEN CONCLUDED THAT SAMPLES OF MUD YIELDED MORE RELIABLE BACTERIOLOGICAL EVIDENCE OF THE DEGREE OF FAECAL POLLUTION THAN DO WATER SAMPLES. FIGURES ON THE DECOMPOSITION OF CELLULOSE ARE ALMOST SIMILAR TO THOSE APPLYING TO MANY DANISH LAKES, BUT THE LATTER ARE NOT THE MAXIMUM NUMERICAL VALUES. SULPHUR DECOMPOSITION IS INSIGNIFICANT AS COMPARED WITH MOST DANISH LAKES. THE LARGEST TOTAL SULPHITE REDUCTION WAS ASCERTAINED FOR LOCALITY 6 (NUMBER OF BACTERIA 4140/G). SULPHATE REDUCTION BY DESULPHO-VIBRIO DESULFURICANS APPEARED ONLY IN 8 SAMPLES OUT OF THE 17. SULPHUR OXIDATION BY MEMBERS OF THE THIOBACILLUS FAMILY WAS ASCERTAINED ONLY FOR THREE LOCATIONS. (JONES-WISCONSIN)

073360 W74-08322

INCREASED DENITRIFICATION IN SOILS BY ADDITIONS OF SULFUR AS AN ENERGY SOURCE

MANN, L. D.; FOCHT, D. D.; JOSEPH, H. A.; STOLZY, L. H.

CALIFORNIA UNIV., RIVERSIDE. DEPT. OF SOIL SCIENCE AND AGRICULTURAL ENGINEERING.

JOURNAL OF ENVIRONMENTAL QUALITY, VOL 1, NO 3, P 329-332, JULY-SEPTEMBER, 1972. 1 FIG, 6 TAB, 18 REF.,

Journal Announcement: SWRA0716

DENITRIFICATION RATES WERE STUDIED IN FOUR LARGE SOIL COLUMNS USING HANFORD SANDY LOAM AND MORENO SILTY CLAY LOAM SOILS. ONE COLUMN OF EACH SOIL WAS AMENDED WITH SULFUR TO SERVE AS AN ENERGY SOURCE FOR THE BACTERIUM THIOBACILLUS DENITRIFICANS. LIMESTONE WAS ALSO ADDED AS A PH BUFFER. THE OTHER COLUMN OF EACH SOIL WAS LEFT UNTREATED TO SERVE AS A CONTROL. A SOLUTION OF CA(NO3)2 CONTAINING 425 PPM NO3-N WAS PERFUSED CONTINUOUSLY THROUGH THE COLUMNS. THE COLUMNS WERE MONITORED PERIODICALLY AT DEPTHS OF 10, 30, 50, 70, AND 90 CM FOR NITRATE, NITRITE, REDOX POTENTIAL AND MICROBIAL NUMBERS. HIGHLY ANAEROBIC CONDITIONS DEVELOPED IN ALL COLUMNS. ALL OF THE NITRATE WAS REDUCED IN EACH COLUMN, AND NITRATES PENETRATED TO LOWER DEPTHS IN THE UNTREATED COLUMNS. NITRITE CONCENTRATIONS WERE FOUND TO BE NEGLIGIBLE. SULFUR ADDITIONS TO FIELD SOILS WHICH ARE LOW IN MICROBIAL ENERGY SOURCES COULD BE AN EFFECTIVE METHOD OF REDUCING THE NITRATE LEVEL IN WATERS PERCOLATING THROUGH THE PROFILE. (SKOGERBOE-COLORADO STATE)

070055 W74-05409

THE MICROBIOLOGY OF ACID MINE WATER TREATMENT IN PACKED BED COLUMNS

UNZ, R. F.; LIEBERMAN, M. T.

PENNSYLVANIA STATE UNIV., UNIVERSITY PARK. DEPT. OF CIVIL ENGINEERING.

AVAILABLE FROM THE NATIONAL TECHNICAL INFORMATION SERVICE AS PB-229 649, $4.00 IN PAPER COPY, $1.45 IN MICROFICHE. INSTITUTE FOR RESEARCH ON LAND AND WATER RESOURCES, PENNSYLVANIA STATE UNIVERSITY, RESEARCH PUBLICATION NO. 77, DECEMBER 1973. 73 P, 19 FIG, 8 TAB, 36 REF. OWRR A-024-PA(1). 14-31-0001-4038.,

Journal Announcement: SWRA0711

PERCOLATION OF ACID MINE WATER THROUGH COLUMNS OF EITHER ARGILLITE STONE OR 1.5 IN. (3.8 CM) POLYPROPYLENE TRICKLING FILTER MEDIUM RESULTED IN OXIDATION OF CONSTITUENT FERROUS IRON. FROM 87 TO 96 PER CENT OF THE INFLUENT FERROUS IRON COULD BE OXIDIZED IN PASSAGE OF MINE WATER THROUGH A TWO FOOT (61 CM) COLUMN OF SYNTHETIC FILTER MEDIUM AT A HYDRAULIC LOADING OF 1.3 GPD/SQ. FT. (52.7 1PD/M2) EFFECTIVE SURFACE AREA OF MEDIUM. FERROUS IRON OXIDATION WAS MEDIATED BY CHEMOLITHOTROPHIC BACTERIA WHICH WERE ISOLATED AND IDENTIFIED AS THIOBACILLUS FERROOXIDANS. IRON ENCRUSTED FILTER MEDIUM SOLIDS WERE FOUND TO CONTAIN ORGANIC GELATINOUS MATRICES IN WHICH MICROORGANISMS WERE EMBEDDED. SEVERAL HETEROTROPHIC MICROORGANISMS WERE ISOLATED FROM MATRICES AND SOLIDS. IRON OXIDIZING BACTERIA BUT NOT HETEROTROPHS WERE SENSITIVE TO A QUATERNARY AMMONIUM COMPOUND AND THE FERROUS IRON OXIDATION WAS CURTAILED IN DISINFECTED FILTER MEDIUM. SEVERAL MORPHOLOGICALLY DISTINGUISHABLE IRON OXIDIZING BACTERIA WERE ISOLATED FROM MINE WATER ON SOLID FERROUS IRON CULTURE MEDIA ALTHOUGH EFFORTS TO RELIABLY ENUMERATE THE BACTERIA USING SPREAD PLATING AND MEMBRANE FILTER CULTURE PROCEDURES WERE UNSUCCESSFUL. IN THIS REGARD, IT WAS NECESSARY TO USE A MICROTITRE PLATE-DILUTION DISPERSION TECHNIQUE TO CULTURE THE BACTERIA PRESENT IN NATURAL SAMPLES FROM WHICH MOST PROBABLE NUMBER (MPN) ESTIMATES OF CELL NUMBERS COULD BE MADE.

068236 W74-03597
DISSIMILATORY REDUCTION OF INORGANIC SULFUR BY FACULTATIVELY ANAEROBIC MARINE BACTERIA
TUTTLE, J. H.; JANNASCH, H. W.
WOODS HOLE OCEANOGRAPHIC INSTITUTION, MASS.
JOURNAL OF BACTERIOLOGY, VOL 115, NO 3, P 732-737, SEPTEMBER 1973. 5 TAB, 26 REF.,
Journal Announcement: SWRA0707

GROWTH EXPERIMENTS WERE CONDUCTED UTILIZING NEWLY ISOLATED FACULTATIVELY ANAEROBIC MARINE BACTERIA FOR THE PURPOSE OF DEMONSTRATING DISSIMILATORY REDUCTION OF THIOSULFATE AND SULFITE. THREE STRAINS OF THE ISOLATES, WHICH RESEMBLED A THIOBACILLI-TYPE BACTERIA, WERE USED. INORGANIC SULFUR COMPOUNDS OTHER THAN SULFATE, WERE ANAEROBICALLY REDUCED IN A BASAL SALTS MEDIUM IN THREE PATTERNS: (1) SULFITE AND THIOSULFATE WERE REDUCED TO SULFIDE, AND TETRATHIONATE WAS REDUCED TO THIOSULFATE; (2) TETRATHIONATE WAS REDUCED TO THIOSULFATE ONLY; OR (3) THIOSULFATE WAS REDUCED TO SULFIDE ONLY WHEN PYRUVATE WAS THE SUBSTRATE. COMPARISON OF ANAEROBIC GROWTH IN THE PRESENCE OR ABSENCE OF INORGANIC SULFUR COMPOUNDS INDICATED TRUE DISSIMILATORY REDUCTIONS. EVIDENCE THAT THESE REDUCTIONS INVOLVE DISSIMILATION OF INORGANIC SULFUR ARE (1) THE FAILURE OF THE BACTERIA TO GROW ANAEROBICALLY IN THE ABSENCE OF A REDUCED SULFUR COMPOUND, OR (2) THE SIGNIFICANT INCREASE OF ANAEROBIC GROWTH IN THE PRESENCE OF A REDUCED SULFUR COMPOUND. THE OBSERVED INCREASE MAY BE AN EXPRESSION OF INCREASED GROWTH RATE, INCREASED CELL YIELD, OR BOTH. THE REDUCTION OF TETRATHIONATE BY THE ISOLATES 12W AND 16B APPEARS TO BE CONSISTENT WITH THAT DESCRIBED FOR BACTERIUM PARATYPHOSUM-B AND CITROBACTER. ALTHOUGH NONE OF THE ISOLATES WAS ABLE TO USE SULFATE AS AN ELECTRON ACCEPTOR, IT IS CLEAR THAT ASSIMILATORY REDUCTION OF SULFATE OCCURS WHEN SULFATE IS THE SOLE SULFUR SOURCE IN GROWING CULTURES. (MORTLAND-BATTELLE)

067163 W74-02263
EFFLUENT TREATMENT AT MAN-MADE FIBRE PRODUCTION UNITS
JONES, T. R.
COURTAULDS LTD., COVENTRY (ENGLAND). RESEARCH DIV.
EFFLUENT AND WATER TREATMENT JOURNAL, VOL 12, P 352-355, 1972.,
Journal Announcement: SWRA0705

MOST TEXTILE FIBER PRODUCTION TECHNOLOGIES INVOLVE DRY PROCESSES, SUCH AS THE SPINNING OF ACETATE, ACRYLIC, POLYAMIDE, POLYESTER, AND GLASS FIBERS, THUS CAUSING NO EFFLUENT PROBLEMS. OTHERS GIVE RISE TO EFFLUENTS THAT ARE CONVENIENTLY TREATABLE BY BIOLOGICAL METHODS, SUCH AS WET SPINNING AND FIBER WASHING WASTES. REMOVAL OF CYANIDE IS NECESSARY WITH STEEL TIRE CORDS WHICH REQUIRE BRASS PLATING, AND WITH CARBONIZED FIBERS WHICH EMIT HYDROGEN CYANIDE. THE OLDEST AND MOST IMPORTANT MAN-MADE FIBER, VISCOSE RAYON, CONSUMES LARGE AMOUNTS OF WATER AND REQUIRES SODIUM HYDROXIDE, CARBON DISULFIDE, ZINC SULFATE, AND SULFURIC ACID AS MAJOR CHEMICALS IN THE MERCERIZATION, XANTHATION, RIPENING, CELLULOSE REGENERATION, COAGULATION, AND SPINNING STAGES. PROCESS ECONOMY, AND ENVIRONMENTAL PROTECTION CALL FOR OPTIMUM CHEMICAL RECOVERY, AS WELL AS FOR EFFLUENT TREATMENT TO REMOVE BOD-CONSUMING HEMICELLULOSES ORIGINATING FROM THE WOOD PULP (MOSTLY SPRUCE AND EUCALYPTUS). ZINC SULFATE, WHICH IS TOXIC AND MOST OBJECTIONABLE, CAN BE REMOVED FROM EFFLUENTS BY ION-EXCHANGED RESINS AND/OR REACTION WITH SODIUM HYDROXIDE AFTER PRELIMINARY NEUTRALIZATION WITH CALCIUM HYDROXIDE. SULFIDE-BEARING ALKALINE SPENT LIQUORS ARE CONVENTIONALLY TREATED WITH THIOBACILLUS THIOOXIDANS, USING THE ACTIVATED SLUDGE TECHNIQUE. CORRECT CHOICE OF FIBER DYES AND PIGMENTS PERMITS CLOSED-CIRCUIT OPERATION AND AVOIDANCE OF COLORED EFFLUENTS. ACCIDENTAL SPILLS MUST BE PREVENTED BY CAREFUL STORAGE OF CHEMICALS, INSTALLATION OF TRAPS, AND WELL-PLANNED EFFLUENT MONITORING AND SAFE FACTORY HOUSEKEEPING PRACTICES. (WITT-IPC)

066970 W74-01946
ACIDOPHILIC THIOBACILLI IN THE RIVER SIRPPUJOKI
NIEMELA, S. I.; TOUVINEN, O. H.
HELSINKI UNIV. (FINLAND). DEPT. OF MICROBIOLOGY.
J GEN MICROBIOL. VOL 73, NO 1, P 23-28. 1972. ILLUS.,
Journal Announcement: SWRA0704

NUMBERS OF ACIDOPHILIC THIOSULFATE-OXIDIZING AND IRON-OXIDIZING THIOBACILLI IN THE RIVER SIRPPUJOKI (SW FINLAND) WERE MONITORED THROUGH ONE ANNUAL CYCLE. A NUMBER OF PHYSICAL AND CHEMICAL ENVIRONMENTAL VARIABLES OF THE RIVER WATER WERE DETERMINED (TEMPERATURE, DISCHARGE, PH VALUES, TITRATABLE ACIDITY, AND CONCENTRATIONS OF MN, FE AND SULFATE). THIOBACILLI IN RIVER WATER APPEARED MAINLY TO HAVE BEEN WASHED IN FROM THE SOIL. ONCE IN THE RIVER A SLOW LOSS OF VIABILITY OCCURRED, STRONGLY INFLUENCED BY THE TEMPERATURE. THE METHODS FOR QUANTITATIVE COLONY COUNTS OF ACIDOPHILIC THIOBACILLI WERE DEEMED UNSATISFACTORY.--COPYRIGHT 1973, BIOLOGICAL ABSTRACTS, INC.

061526 W73-12127
CHARACTERIZATION OF THIOBACILLUS SPECIES BY GAS-LIQUID CHROMATOGRAPHY OF CELLULAR FATTY ACIDS
AGATE, A. D.; VISHNIAC, W.
ROCHESTER UNIV., N.Y. DEPT. OF BIOLOGY.
ARCHIV FUR MIKROBIOLOGIE, VOL 89, NO 3, P 257-267, FEBRUARY 9, 1973. 5 FIG, 2 TAB, 14 REF.,
Journal Announcement: SWRA0619

FATTY ACIDS OF 18 STRAINS REPRESENTING 10 SPECIES OF THIOBACILLUS WERE EXTRACTED FROM WHOLE CELLS AND EXAMINED AS METHYL ESTERS BY GAS-LIQUID CHROMATOGRAPHY. BOTH VISUAL AND QUANTITATIVE COMPARISON OF THE RESULTING CHROMATOGRAMS FOR THE PRESENCE AND RELATIVE AMOUNTS OF MAJOR PEAKS ALLOWED RAPID DIFFERENTIATION BETWEEN SUCH CLOSELY RELATED SPECIES AS THIOBACILLUS NEAPOLITANUS AND T. THIOPARUS AND OF EIGHT OTHER SPECIES. EXCEPT FOR A FEATURE COMMON TO ALL THIOBACILLI TESTED, T. THIOOXIDANS, T. NEAPOLITANUS AND T. THIOPARUS EACH POSSESSED A CHARACTERISTIC FATTY ACID METHYL ESTER PROFILE THAT WAS EXHIBITED BY ALL THE STRAINS OF THAT SPECIES. HENCE, THE THIOBACILLI COULD BE DIVIDED INTO THREE DISTINCT GROUPS. IT WAS POSSIBLE TO USE THE GAS-LIQUID CHROMATOGRAPHIC PATTERNS OF THE CELLULAR FATTY ACIDS FOR RAPID IDENTIFICATION OR GROUPING OF THESE MICROORGANISMS SINCE THE FATTY ACID COMPOSITION OF THE GENUS THIOBACILLUS THUS APPEARED TO BE OF TAXONOMIC SIGNIFICANCE. (LITTLE-BATTELLE)

055751 W73-06006
COAL AND COAL MINE DRAINAGE
BOYER, J. F.; GLEASON, V. E.
BITUMINOUS COAL RESEARCH INC., PITTSBURGH, PA.
JOURNAL WATER POLLUTION CONTROL FEDERATION, VOL 44, NO 6, P 1088-1093, JUNE 1972. 52 REF.,
Journal Announcement: SWRA0610

A LITERATURE REVIEW IS PRESENTED OF STUDIES ON COAL AND COAL MINE DRAINAGE. THE STUDIES COVER (1) PYRITE OXIDATION, (2) ACID MINE DRAINAGE, (3) ACID PRODUCTION, (4) HYDROLOGIC EFFECTS OF MINING, (5) WASTE TREATMENT, AND (6) RECLAMATION. (HOLOMAN-BATTELLE)

055264 W73-05262
ECOLOGY OF SULFUR-OXIDIZING BACTERIA IN HOT ACID SOILS
FLIERMANS, C. B.; BROCK, T. D.
INDIANA UNIV., BLOOMINGTON. DEPT. OF MICROBIOLOGY.
JOURNAL OF BACTERIOLOGY, VOL 111, NO 2, P 343-350, AUGUST, 1972. 4 FIG, 1 TAB, 18 REF.,
Journal Announcement: SWRA0609

THE DISTRIBUTION OF THE SULFUR-OXIDIZING BACTERIA THIOBACILLUS THIOOXIDANS AND SULOLOBUS ACIDOCALDARIUS WERE STUDIED AS A FUNTION OF SOIL TEMPERATURE AND PH IN SEVERAL THERMAL AREAS OF YELLOWSTONE NATIONAL PARK. BACTERIAL NUMBERS WERE MEASURED BY A MOST-PROBABLE NUMBER (MPN) METHOD AND BACTERIAL ACTIVITY WAS DETERMINED BY ISOTOPIC CARBON DIOXIDE FIXATION. A DILUTION TECHNIQUE WAS USED TO MEASURE THE PH OF HIGHLY ACIDIC SOILS AND THE AMOUNT OF ELEMENTAL SULFUR IN SOIL SAMPLES WAS DETERMINED BY A DIRECT SPECTROPHOTOMETRIC METHOD. THIOBACILLUS THIOOXIDANS IS PRESENT AT TEMPERATURES BELOW 55C AND SULFOLOBUS ACIDOCALDARIUS AT TEMPERATURES OF 55-85C. THE DATA INDICATE THAT SULFUR-OXIDIZING BACTERIA ARE RESPONSIBLE FOR PRODUCTION OF SULFURIC ACID IN ACIDIC THERMAL HABITATS. PHYSICAL AND CHEMICAL PARAMETERS OF THESE SOILS WERE ALSO MEASURED AND ARE DESCRIBED. (MORTLAND-BATTELLE)

054978 W73-05280
A PH-DEPENDENT SUCCESSION OF IRON BACTERIA
MITCHELL, [illegible].
HARVARD UNIV. CAMBRIDGE, MASS. LAB. OF APPLIED MICROBIOLOGY.
ENVIRONMENTAL SCIENCE AND TECHNOLOGY, VOL 6, NO 8, P 809-812, SEPTEMBER, 1972. 1 FIG, 5 TAB, 14 REF.,
Journal Announcement: SWRA0609

A FILAMENTOUS IRON BACTERIUM, THIOBACILLUS FERROOXIDANS, WAS EXAMINED FOR ITS ROLE IN AFFECTING THE PH-DEPENDENT OXIDATION OF IRON. THE ORGANISM, SELECTIVELY ISOLATED FROM SAMPLES OBTAINED FROM A WIDE VARIETY OF SOURCES INCLUDING COAL MINES, IRON-CONTAINING STREAMS, AND ZINC MINES, WAS CULTURED AT DIFFERENT PH RANGES (3.5 TO 5.5) IN ORDER TO DETERMINE THE RATE OF FERROUS IRON OXIDATION AT THE VARIOUS PH'S. THE ORGANISM CATALYZES IRON OXIDATION IN THE PH RANGE 4.5 TO 3.5. AT PH GREATER THAN 4.5, ABIOTIC IRON OXIDATION PROCEEDS RAPIDLY. AT PH LESS THAN 3.5, T. FERROOZIDANS SIGNIFICANTLY CATALYZES IRON OXIDATION. THE ACTIVITY OF THESE BACTERIA IN THE DEGRADATION OF IRON MAY DIRECTLY AFFECT THE RATE OF ACIDITY PRODUCTION IN COAL MINE WATERS. (LONG-BATTELLE)

054489 W73-04567
METABOLIC ROLE OF SULFATES AND SULFIEDS PRODUCING BACTERIA IN POLLUTION OF WATERS
ALEEM, M. I. H.
KENTUCKY WATER RESOURCES INST., LEXINGTON.
AVAILABLE FROM THE NATIONAL TECHNICAL INFORMATION SERVICE AS PB-214 485, $3.00 IN PAPER COPY, $0.95 IN MICCROFICHE. RESEARCH REPORT NO 46, 1972. 52 P, 5 FIG, 10 TAB, 34 REF. OWRR A-016-KY (1), 14-01-0001-1636.,
Journal Announcement: SWRA0608

SINCE THE ACTIVITIES OF SULFUR BACTERIA ARE KNOWN TO BE RESPONSIBLE FOR MANY OF THE CHARACTERISTICS OF ACID-MINE WASTES, INVESTIGATIONS WERE AIMED AT ELUCIDATING THE PHYSIOLOGY AND METABOLISM OF THESE BACTERIA AS THIS APPROACH APPEARS TO BE THE KEY TO THE DEVELOPMENT OF CONTROL MEASURES. THE INVESTIGATIONS SHOW THAT THIOBACILLI ARE THE MOST PROLIFIC PRODUCERS OF SULFATES FROM THE OXIDATION OF SULFUR COMPOUNDS. UNDER LABORATORY CONDITIONS, AN AVERAGE POPULATION OF THIOBACILLI APPROXIMATES 10 TO THE EIGHTH POWER CELL/CC (OR 0.075 MG DRY WEIGHT) IN A GROWTH MEDIUM. THE RATE OF SULFATE PRODUCTION WAS IN THE ORDER OF 10 TO 40 MICROMOLES/HR/MG DRY WT. OF CELLS. ASSUMING THAT THE RATE OF SULFUR TRANSFORMATION IN NATURAL ENVIRONMENTS HAVING ENRICHMENT OF THESE ORGANISMS IS APPROXIMATELY 10% OF THE TRANSFORMATIONS OBSERVED UNDER LABORATORY CONDITIONS, THEN THE THIOBACILLI COULD PRODUCE AS MUCH AS 100 TO 400 MOLES OF SULFATES IN ONE HOUR IN THE UPPER 1-FOOT OF WATER IN AN AREA OF ONE ACRE. SUCH A HIGH LEVEL OF SULFATE PRODUCTION POSES A SERIOUS ENVIRONMENTAL THREAT. CONCENTRATIONS AS LOW AS 0.000001 TO 10 TO THE MINUS SEVENTH POWER. OF CHLORO OR BROMO-SUBSTITUTED PHENOLS ARE EFFECTIVE IN THE COMPLETE INHIBITION OF THE ENERGY METABOLISM OF THIOBACILLI. THIS COULD BE USEFUL IN DESIGNING EXPERIMENTS TO CONTROL SULFATE PRODUCTION BY THE SULFUR OXIDIZING BACTERIA. (WOODWARD-USGS)

054154 W73-04818
DEMONSTRATION OF RHODANESE ACTIVITY IN POLYACRYLAMIDE GELS
MURPHY, J. R.; FRANKENFELD, J.; CALVERT, J.; TILTON, R. C.
CONNECTICUT UNIV. HEALTH CENTER, HARTFORD.
APPLIED MICROBIOLOGY, VOL 24, NO 2, P 283-285, AUGUST 1972. 1 FIG, 10 REF.,
Journal Announcement: SWRA0608

RHODANESE ACTIVITY FROM CRUDE EXTRACTS OF THIOBACILLUS SP. STRAIN IV-85 WAS DEMONSTRATED IN POLYACRYLAMIDE GELS AFTER INCUBATION IN THE REACTION MIXTURE BY STAINING WITH DICHLOROINDOPHENOL IN THE PRESENCE OF METHYLPHENAZONIUM METHOSULFATE. THE SENSITIVITY OF THE STAINING SYSTEM WAS FOUND TO BE 0.8 MICROMOLES OF SULFITE. DUE TO THE SPECIFICITY OF THE PROCEDURE FOR THE PRESENCE OF SULFITE, THE DETECTION OF ENZYMES OF EITHER THE SULFUR OXIDATION PATHWAY, OR THE SULFATE REDUCTION PATHWAY, WHICH PRODUCE SULFITE, COULD BE POSSIBLE WITH APPROPRIATE ALTERATION OF THE REACTION MIXTURE. (LONG-BATTELLE)

051284 W73-01609
INORGANIC SULFUR OXIDATION BY IRON-OXIDIZING BACTERIA
LUNDGREN, G.
SYRACUSE UNIV., N.Y. DEPT. OF BIOLOGY.
COPY AVAILABLE FROM GPO SUP DOC, EP2.10:14010 DAY 06/71, $1.25; MICROFICHE FROM NTIS AS PB-213 006, $0.95. ENVIRONMENTAL PROTECTION AGENCY, WATER POLLUTION CONTROL RESEARCH SERIES, JUNE 1971. 149 P. 21 FIG, 32 TAB, 98 REF.,
Journal Announcement: SWRA0603

SULFUR METABOLISM OF THIOBACILLUS FERROOXIDANS AND RHODANESE-SULFITE OXIDASE ENZYMES WERE STUDIED. AS DISCLOSED BY ELECTRON MICROSCOPE EXAMINATION, THE PURIFIED CELL ENVELOPE OF LIPOPOLYSACCHARIDE CONTAINS A VERY HIGH QUANTITY OF FERRIC IRON. A NEW COLORIMETRIC WHOLE CELL ASSAY WAS DEVELOPED TO STUDY IRON OXIDATION. THE PRESENCE OF PYROPHOSPHATASE ENZYME WAS REVEALED FOR THE FIRST TIME IN CHEMOLITHOTROPHIC MICROORGANISMS. STUDY OF ENERGY SOURCES DISCLOSED THAT THE CHEMOLITHTROPHIC T. FERROOXIDANS CAN EVOLVE HETEROTROPHIC MECHANISMS AND GROW ON GLUCOSE, FOLLOWING THE ENTNER-DOUDOROFF PATHWAY. (WILDE-WISCONSIN)

051265 W73-01629

ENVIRONMENTAL EFFECTS ON THE GROWTH OF NITROGEN-FIXING BACTERIA

HILL, S.; DROZD, J. W.; POSTGATE, J. R.

AGRICULTURAL RESEARCH COUNCIL, BRIGHTON (ENGLAND). UNIT OF NITROGEN FIXATION.

JOURNAL OF APPLIED CHEMISTRY AND BIOTECHNOLOGY, VOL 22, P 541-558, 1972. 8 FIG, 3 TAB, 59 REF.,

Journal Announcement: SWRA0603

A SYSTEMATIC STUDY SURVEY OF NITROGEN-FIXING BACTERIA IN CONTINUOUS CULTURES IN THE LABORATORY OVER THE PAST FEW YEARS IS GIVEN. NUTRITIONAL STATUS OF POPULATIONS AND THE PHYSIOLOGY OF NITROGEN FIXATION, ESPECIALLY THAT OF THE AEROBIC BACTERIUM, AZOTOBACTER CHROOCOCCUM, WERE INVESTIGATED. SENSITIVITY TO EXCESSIVE OXYGENATION WAS SPECIFIC TO NITROGEN-FIXING POPULATIONS AND WAS NOT SHOWN BY THOSE ASSIMILATING AMMONIA; C OR P-LIMITED POPULATIONS WERE HYPERSENSITIVE. NITROGEN-FIXING AEROBES ARE NOT THE ONLY MICROORGANISMS TO POSSESS OXYGEN-SENSITIVE ENZYMES OR ELECTRON-TRANSPORT SYSTEMS WHICH CAN BE INTERFERED WITH BY OXYGEN. CASUAL EXPERIENCE SUGGESTS THEY MAY OCCUR WITH AEROBACTER AEROGENES AND THIOBACILLUS THIOPARUS. YIELD STUDIES REQUIRE THAT THE NUTRITIONAL STATUS OF THE WHOLE POPULATION BE KNOWN RIGIDLY TO BE LIMITED BY THE ENERGY SOURCE. IT IS EXTREMELY DIFFICULT TO OBTAIN STABLE C-LIMITED POPULATIONS OF AEROBIC NITROGEN-FIXING BACTERIA; THOUGH BATCH CULTURES HAVE GIVEN VALUABLE INFORMATION, THE EXTENSION OF BATCH CULTURE TECHNIQUES TO ORGANISMS OF MORE EXOTIC METABOLISM MAY ENTAIL RISK. CHEMOSTAT VALUE TO PROVIDE CONTROLLED NUTRITIONAL STATUS FOR STUDYING REPRESSION AND DEREPRESSION PHENOMENA IS SELF-EVIDENT AND WIDELY ACCEPTED; THE TECHNIQUE LENDS ITSELF TO STUDY OF POPULATION DENSITY EFFECTS AND IS ALMOST THE ONLY WAY OF OBTAINING PARTIALLY REPRESSED POPULATIONS. (JONES-WISONSIN)

050119 W73-00422

PHYSIOLOGY OF A NEW FACULTATIVELY AUTOTROPHIC THERMOPHILIC THIOBACILLUS

WILLIAMS, R. A. D.; HOARE, D. S.

TEXAS UNIV., AUSTIN. DEPT. OF MICROBIOLOGY.

JOURNAL OF GENERAL MICROBIOLOGY, VOL 70, P 555-566, 1972. 1 FIG, 8 TAB, 42 REF.,

Journal Announcement: SWRA0601

A NEW THERMOPHILIC THIOBACILLUS (G PLUS C EQUALS 66.2 MOL PERCENT) HAS BEEN ISOLATED IN PURE CULTURE. THIS FACULTATIVELY AUTOTROPHIC NON-SPORE-FORMING THERMOPHILE WAS ISOLATED FROM WATER SAMPLES COLLECTED AT YELLOWSTONE NATIONAL PARK. THE TEMPERATURE OPTIMUM FOR GROWTH WAS 50 DEGREES. HETEROTROPHIC GROWTH OCCURRED ON NUTRIENT BROTH, BUT NOT ON SINGLE ORGANIC COMPOUNDS. NO ALPHA-KETO-GLUTARATE DEHYDROGENASE WAS PRESENT, BUT UNRESTRICTED ACETATE INCORPORATION TOOK PLACE VIA THE GLYOXYLATE CYCLE. (BYRD-BATTELLE)

050078 W73-00300

BIOLOGICAL CONTROL OF ACID MINE POLLUTION

WALSH, F.; MITCHELL, R.

HARVARD UNIV., CAMBRIDGE, MASS.

JOURNAL WATER POLLUTION CONTROL FEDERATION, VOL. 44, NO. 5, P 763-768, MAY 1972. 2 FIG, 3 TAB, 15 REF.,

Journal Announcement: SWRA0601

THREE POSSIBLE BIOCONTROLS WERE PRESENTED TO REDUCE THE ACIDITY IN ACID MINE DRAINAGE, BASED ON DISRUPTING THE SUCCESSION OF IRON BACTERIA BY UPSETTING THE ACTIVITY OF THE ACID-TOLERANT STALKED IRON BACTERIUM IN THIS SUCCESSION. THE THREE CONTROLS INCLUDE: (1) PARTIALLY NEUTRALIZING ACID MINE DRAINAGE TO PH 4.3 TO INHIBIT THE STALKED BACTERIA AND THIOBACILLUS FERROOXIDANS; (2) REMOVING ATTACHMENTS FOR THE STALKED-BACTERIA AT THE SITE OF PYRITE DEGRADATION BY ADDITIONS OF SURFACE-ACTIVE AGENTS TO INFLUENCE MINE WATERS; (3) ADDING HETEROTROPHIC BACTERIA CAPABLE OF GROWTH ON A MEDIUM WITH STALKED IRON BACTERIA AS THE SOLE CARBON SOURCE. CHARACTERISTICS OF THE IRON BACTERIA THIOBACILLUS SPP., GALLIONELLA SPP., AND SPHAEROTILUS NATANS IN RELATION TO ACID MINE POLLUTION WERE ALSO DESCRIBED. (LONG-BATTELLE)

050000 W73-00338
COMPARISON OF THE KINETICS OF THIOSULFATE OXIDATION BY THREE IRON-SULFUR OXIDIZERS
BOUNDS, H. C.; COLMER, A. R.
NORTHEAST LOUISIANA UNIV., MONROE, DEPT. OF BIOLOGY.
CANADIAN JOURNAL OF MICROBIOLOGY, VOL 18, NO 6, P 735-740, JUNE 1972. 5 FIG, 2 TAB, 11 REF.,
Journal Announcement: SWRA0601

THE IRON BACTERIA, THIOBACILLUS FERROOXIDANS, FERROBACILLUS FERROOXIDANS, AND FERROBACILLUS SULFOOXIDANS, ORIGINALLY ISOLATED FROM ACIDIC WATERS OF BITUMINOUS COAL MINES OF WEST VIRGINIA AND PENNSYLVANIA, WERE CHARACTERIZED VIA A KINETIC STUDY OF THEIR THIOSULFATE METABOLISM. THIS WAS BASED ON THE DISAPPEARANCE OF THIOSULFATE AND TETRATHIONATE WHICH WAS DETERMINED COLORIMETRICALLY FROM CULTURE MEDIA CONTAINING THE THREE ORGANISMS. DETERMINATIONS WERE PERFORMED UNDER VARYING CONDITIONS OF TEMPERATURE, PH, AND OXYGEN TENSION. THE SULFUR METABOLISM OF THIOBACILLUS FERROOXIDANS, FERROBACILLUS FERROOXIDANS, AND FERROBACILLUS SULFOOXIDANS WAS FOUND TO DIFFER IN THE RATE OF UTILIZATION OF THIOSULFATE AND TETRATHIONATE, WITH TETRATHIONATE SHOWING THE MOST SIGNIFICANT DIFFERENCE BETWEEN THE THREE ORGANISMS. THE APPARENT K SUB M VALUES OF THE THREE ORGANISMS RANGED FROM 0.02-0.05 M FOR T. FERROOXIDANS AND F. SULFOOXIDANS TO 5-7 FOR F. FERROOXIDANS. INCREASING THE TEMPERATURE CAUSED A GREATER EFFECT ON THIOSULFATE OXIDATION BY F. FERROOXIDANS THAN WITH THE OTHER TWO AS SHOWN BY THE APPARENT ACTIVATION ENERGY VALUES. THE INITIAL PH OF THE MEDIUM DETERMINED THE RATE OF THIOSULFATE OXIDATION. IF THE INITIAL PH WAS 4.0-4.5, A SHARP BREAK IN OXYGEN UPTAKE WAS SHOWN BY T. FERROOXIDANS AND F. SULFOOXIDANS AFTER 20-30 MIN, BUT NOT WITH F. FERROOXIDANS. (LONG-BATTELLE)

049084 W72-14793
PHYSIOLOGY OF ACIDOPHILIC BACTERIA OF ACID MINE WATER
MANNING, L.; COOK, M.
MARYLAND UNIV., COLLEGE PARK. WATER RESOURCES RESEARCH CENTER.
AVAILABLE FROM THE NATIONAL TECHNICAL INFORMATION SERVICE AS PB-212 377, $3.00 IN PAPER COPY, $0.95 IN MICROFICHE. COMPLETION REPORT, FEBRUARY 1972. 50 P. 15 FIG, 5 TAB, 37 REF. OWRR A-016-MD (2).,
Journal Announcement: SWRA0524

TWO NEW ACIDOPHILIC BACTERIA (STRAINS M-1 AND M-2) WERE ISOLATED, CHARACTERIZED, AND PLACED IN THE GENUS PSEUDOMONAS, AS PSEUDOMONAS ACIDOPHILA, SP. N. OBLIGATE ACIDOPHILES UNABLE TO GROW AT NEUTRALITY, THEY ARE CAPABLE OF RAPID AND VIGOROUS GROWTH AT PH 3.5, WITH A RANGE OF PH 2.5-4.5, IN AN ESPECIALLY DEVISED YEAST EXTRACT-GLUCOSE SALTS MEDIUM. UNLIKE THE FERROBACILLI AND THIOBACILLI, THEY ARE HETEROTROPHS (THAT IS, USE ORGANIC COMPOUNDS FOR GROWTH) RATHER THAN AUTOTROPHS. THEY DIFFER FROM OTHER ACID-TOLERANT HETEROTROPHIC BACTERIA OF SUCH ENVIRONMENTS IN BEING OBLIGATE ACIDOPHILES AND FAIL TO GROW ON ROUTINE BACTERIOLOGICAL CULTURE MEDIA. AN ACIDIC YEAST EXTRACT-GLUCOSE SALTS CULTURE MEDIUM WAS DEVELOPED FOR HETEROTROPHS SUCH AS P. ACIDOPHILA AND AN IMPROVED IRON SALTS AGAR MEDIUM FOR THE AUTOTROPHIC IRON-OXIDIZING FERROBACILLI. VARIOUS MORPHOLOGICAL AND PHYSIOLOGICAL CHARACTERISTICS OF THE TWO STRAINS WERE DETERMINED. A LOW LEVEL OF YEAST EXTRACT (0.025-0.050%) STIMULATES GROWTH, BUT GROWTH IS PROGRESSIVELY INHIBITED ABOVE 0.1%. BOTH INORGANIC AND ORGANIC NITROGEN SOURCES ARE UTILIZED FOR GROWTH. GROWTH WITH AMMONIUM SALTS LOWERED THE PH OF THE MEDIUM BUT GROWTH WITH ORGANIC NITROGEN SOURCES SUCH AS L-HISTIDINE, HYDROLYZED CASEIN OR UREA CONSISTENTLY RAISED THE PH FROM AN INITIAL VALUE OF 4.0 TO 5.0 OR HIGHER. (JONES-WISCONSIN)

014814 W72-10356
BACTERIOLOGY OF WATER PIPES
WILSON, C.
JOURNAL OF THE AMERICAN WATER WORKS ASSOCIATION, VOL 36, NO 1, P 52-58, JANUARY 1945.,
Journal Announcement: SWRA0517

THE KINDS AND NUMBERS OF BACTERIA WHICH EXIST IN A GIVEN SITUATION DEPENDS ON THE ENVIRONMENT. WATER DISTRIBUTION SYSTEMS AFFORD CONSTANTLY CHANGING ENVIRONMENTS, AND AS A CONSEQUENCE BACTERIAL FORMS DIFFER FROM PLACE TO PLACE AND FROM SEASON TO SEASON. MOST OF THE BACTERIA WHICH INHABIT WATER PIPES ARE ATTACHED FORMS WHICH BUILD ENCRUSTING COLONIES OR SLIMES OVER THE WALLS OF THE PIPE. THE TYPES USUALLY ENCOUNTERED ARE CRENOTHRIX, BEGGIATOA, AND THIOBACILLUS THIOOXIDANS. THESE BACTERIA AFFECT THE ODOR, TASTE, COLOR, AND TURBIDITY OF WATER. THEY MAY CAUSE PIPE CORROSION WITH THE PRODUCTION OF TUBERCULES, AND MAY ALSO GIVE RISE TO 'RED WATER'. (BRITTON-AWWARF)

044001 W72-09359
CHALCOCITE OXIDATION AND COUPLED CARBON DIOXIDE FIXATION BY THIOBACILLUS FERROOXIDANS
NIELSEN, A. M.; BECK, J. V.
BRIGHAM YOUNG UNIV., PROVO, UTAH. DEPT. OF MICROBIOLOGY.
SCIENCE, VOL. 175, NO. 4026, P 1124-1126, MARCH 10, 1972. 1 FIG, 1 TAB, 8 REF.,
Journal Announcement: SWRA0516

A CULTURE OF THIOBACILLUS FERROOXIDANS, A CHEMOLITHOAUTOTROPHIC BACTERIUM, WAS OBTAINED FROM A COPPER MINE IN ARIZONA FOR USE IN DETERMINING WHETHER THIS BACTERIUM CATALYZES THE OXIDATION OF CU(+) IN CHALCOCITE TO CU(2+) AND SIMULTANEOUSLY FIXES CARBON DIOXIDE. CELL SUSPENSIONS WERE PREPARED BY RESUSPENDING CENTRIFUGE-SEDIMENTED CELLS IN 0.01N SULFURIC ACID TO A CELL DENSITY EQUIVALENT TO ABOUT 1.0 MICROGRAM OF CELLULAR NITROGEN PER MILLILITER. THE CELL SUSPENSION WAS ADDED TO A FLASK CONTAINING A GROUND SAMPLE OF CHALCOCITE (CU2S), KH2PO4, H2SO4, AND CARBON-14-LABELLED NAHCO3. OXYGEN UPTAKE WAS MEASURED DURING THE EXPERIMENT USING MANOMETRIC METHODS WITH WARBURG-TYPE REACTION VESSELS. THE REACTION OF CELL SUSPENSIONS RESULTED IN OXYGEN UPTAKE ACCOMPANIED BY INCREASED SOLUBILIZATION OF COPPER AND FIXATION OF CARBON DIOXIDE. THE RATIO OF OXYGEN CONSUMED TO MICROBIALLY SOLUBILIZED COPPER WAS 0.43. THE ONLY DETECTABLE OXIDIZED PRODUCTS WERE CUPRIC IONS AND AN OXIDIZED FORM OF SULFIDE MINERAL. THEREFORE, THE APPARENT SOURCE OF ENERGY FOR THE CARBON DIOXIDE FIXATION WAS THE CUPROUS COPPER OF THE CHALCOCITE. (SNYDER-BATTELLE)

042891 W72-09318
GROWTH OF OBLIGATE AUTOTROPHIC BACTERIA ON GLUCOSE IN A CONTINUOUS FLOW-THROUGH APPARATUS
PAN, P.; UMBREIT, W. W.
RUTGERS - THE STATE UNIV., NEW BRUNSWICK, N.J. DEPT. OF BACTERIOLOGY.
JOURNAL OF BACTERIOLOGY, VOL. 109, NO. 3, P 1149-1155, MARCH 1972. 7 FIG, 1 TAB, 24 REF.,
Journal Announcement: SWRA0516

NITROSOMONAS EUROPAEA, NITROBACTER AGILIS, THIOBACILLUS DENITRIFICANS, T. NEAPOLITANUS, AND T. THIOPARUS (ALL OBLIGATE AUTOTROPHIC BACTERIA) HAVE BEEN GROWN IN DIALYSIS CULTURE, ON GLUCOSE SALTS MEDIA, IN THE ABSENCE OF THEIR SPECIFIC INORGANIC ENERGY SOURCE. METABOLIC PRODUCTS FOR N. AGILIS GROWN ON NITRITE SALTS MEDIUM WERE IDENTIFIED AS KETO ACIDS. PYRUVIC ACID INHIBITED THIS ORGANISM AT 0.00005 M. KETO ACIDS WERE NOT INHIBITORY FOR THE THIOBACILLI GROWN ON THIOSULFATE MEDIUM. HOWEVER, WHEN T. DENITRIFICANS WAS GROWN ON GLUCOSE WITH DIALYSIS, ADDITION OF 0.00005 M PYRUVATE INHIBITED GROWTH. THUS, IT APPEARS PYRUVATE MAY BE INHIBITORY FOR OTHER AUTOTROPHS, AS HAS BEEN REPORTED FOR T. THIOOXIDANS. (HOLOMAN-BATTELLE)

032470 W71-02278
MICROBIAL FACTOR IN MINE DRAINAGE FORMATION
BAKER, ROBERT A.; WILSHIRE, ALBERT G.
MELLON INST., PITTSBURGH, PA.
AVAILABLE FROM NTIS AS PB-196 113, $0.95 IN MICROFICHE. FOR SALE BY THE SUPERINTENDENT OF DOCUMENTS, US GOVERNMENT PRINTING OFFICE, WASHINGTON, DC 20402. PRICE $0.70 PC ORDER NO 13/4:14010 DKN 11/70. WATER POLLUTION CONTROL RESEARCH SERIES 1410 DKN 11/70, JULY 1970. 68 P, 12 TAB, 22 FIG, 36 REF, APPEND. FWQA PROGRAM GRANT NO 14010DKN.,
Journal Announcement: SWRA0405

THE ROLE OF CHEMOAUTROPHIC ORGANISMS IN THE FORMATION OF ACID MINE DRAINAGE FROM PYRITIC MATERIALS ASSOCIATED WITH COAL MINING HAS BEEN INVESTIGATED BY PILOT PLANT TECHNIQUES. DYNAMIC FLOW, CONTROLLED ENVIRONMENT UNITS WHICH SERVED AS MODELS OF MINES WERE USED. IT WAS DEMONSTRATED THAT THE CONCENTRATION OF ACIDITY, FERROUS AND TOTAL IRON AND SULFATE IN THE EFFLUENT FROM AEROBIC, BIOLOGICALLY-SEEDED OR UNSEEDED PYRITIC BEDS IS ZERO ORDER WITH RESPECT TO FLOW, EXCEPT AT LOW FLOW RATES WHERE MASS TRANSPORT IS DIFFUSION LIMITED. ALGAL GROWTH OCCURRED IN THE ACIDIC, AEROBIC ENVIRONMENT BUT DID NOT AFFECT ACID PRODUCTION. NONAEROBIC SYSTEMS PRODUCE ACIDITY CONSISTING ONLY OF FERROUS IRON. TOTAL ACIDITY IS LOWER FROM BIOLOGICALLY-SEEDED THAN -NONSEEDED AEROBIC SYSTEMS. ACID MINE DRAINAGE WAS NOT SIGNIFICANTLY AFFECTED BY SEEDING WITH THE INDIVIDUAL OR A MIXTURE OF THREE DIFFERENT ORGANISMS BUT WAS INCREASED BY RECYCLE OF THE FLOW AND INCREASED APPRECIABLY UNDER FORCED AERATION. THE RATE IS DIRECTLY RELATED TO THE AVAILABLE PYRITE SURFACE AREA. (SHACKELFORD-FWQA)

018177 W70-08898
THE UTILIZATION OF THIOCYANATE BY A HETEROTROPHIC BACTERIUM
STAFFORD, D. A.; GALLELY, A. G.
UNIVERSITY COLL. OF SOUTH WALES AND MONMOUTHSHIRE, CARDIFF.
JOURNAL GENERAL MICROBIOLOGY, 55, PART 1, P 285-289, 1969. 3 FIG, 8 REF.,
Journal Announcement: SWRA0321

A HETEOROTRPHIC BACTERIUM IS ISOLATED BY PLATING OUT ON A SOLID THIOBACILLUS-ENRICHMENT MEDIUM. CHARACTERISTICS OF THE ORGANISM GIVEN INCLUDE: (1) RAPID POSITIVE RESULT IN THE OXIDASE TEST UTILIZING DENITRIFICATION AS AN ANAEROBIC RESPIRATORY MECHANISM. (2) NO GROWTH TOOK PLACE ON NUTRIENT AGAR AT 4 OVER A PERIOD OF TEN DAYS. (3) PIGMENT IS NOT PRODUCED UNDER ANY CONDITIONS OF GROWTH. (4) THE ORGANISM USED THIOCYANATE AS SOLE SOURCE OF CELLULAR NITROGEN AND SULFUR. IN THE PRESENCE OF EXCESS THIOCYANATE, GROWTH STOPPED SUDDENLY WHENEVER THE CARBON AND ENERGY SOURCE WERE EXHAUSTED. THE ORGANISM FITS THE DEFINITION OF PSEUDOMONAD. CHARACTERISTIC FEATURES OF THE ORGANISM ARE ITS ROUGH AND SMOOTH COLONIAL VARIATIONS. THE POTENTIAL USE OF THE ORGANISM IN THE BIOLOGICAL TREATMENT OF EFFLUENTS IS BROUGHT OUT BY ITS ABILITY TO METABOLIZE BOTH PHENOL AND THIOCYANATE SIMULTANEOUSLY. (RADHAKRISHNAN-TEXAS)

004783 W69-06029
BACTERIAL CORROSION OF CONCRETE IN WATER
FJERDINGSTAD, EINER
TECHNICAL UNIV. OF DENMARK, COPENHAGEN. INST. OF HYGIENE.
WATER RES, VOL 3, NO 1, PP 21-30, JAN 1969. 10 P, 6 FIG, 3 TAB, 15 REF..
Journal Announcement: SWRA0215

CORROSION OF CONCRETE IN WATER OCCURS IN THE PRESENCE OF SULFATE AND SULFUR BACTERIA. THIOBACILLUS SPECIES CAN USE PYRITE AS AN ENERGY SOURCE AND RELEASE SULFURIC ACID TO THE SURROUNDING WATER, WHERE IT CORRODES CONCRETE STRUCTURES. LABORATORY TESTS OF CONCRETE-CORROSION HAZARD MAY BE MADE BY INOCULATING ; GM OF MUD FROM THE SITE WITH BACTERIAL CULTURE AND MONITORING PH. LABORATORY TESTS OF THE GROWTH OF VARIOUS THIOBACILLUS SPECIES SHOW THAT EACH HAS ITS OWN NARROW PH RANGE, SO THAT WITH PRODUCTION OF ACID, THERE IS A SUCCESSION OF SPECIES FROM ALKALINE-TOLERANT TO ACID-TOLERANT TYPES. (KNAPP-USGS)

L

APPENDIX L

AQUATIC SCIENCES AND FISHERIES ABSTRACTS (ASFA) DATABASE

SEARCH #1 OF 1

SEARCH STRATEGY:

[MINE(S) OR MINING]

AND

[DRAINAGE OR WATER(S) OR WASTE(S) OR WASTEWATER(S)]

AND

[PYRIT? OR SULPHIDE OR SULFIDE OR IRON]

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BANK =       1            - CL SYSTEMS LIMITED -         D= 126856  ASF

TITLE:                  The occurrence of Thiobacillus ferrooxidans
                        and arsenic in subarctic streams affected by
                        gold-mine drainage.
AUTHOR/AFFIL:           Brown, E.J.;Lucas, H.V.;Forshaug, J.M. (Inst.
                        Water Resour., Univ. Alaska, Fairbanks, AK
                        99701, USA)
PUBLICATION:            ARCTIC.
                        vol. 35, no. 3, pp. 417-421
                        (1982).
                        JOURNAL ARTICLE
LANGUAGE: En;en,fr.
ASFA  1, 13(03), 1983  ABSTRACT NO 03911
SUBJECT SECTION:   (1)503, (2)445
KEYWORDS:               arsenic; environmental impact; mining;
                        industrial wastes; heavy metals; rivers;
                        freshwater pollution; bacteria;
                        Thiobacillus ferrooxidans;
                        USA, Alaska; Canada, Yukon Territory
AQUATIC ENVIRONMENT:  FRESHWATER
        ABSTRACT:  Thirty-five streams in gold-mining regions
between Rampart, Alaska, and Dawson City, Yukon Territory, were
sampled to determine dissolved arsenic concentrations, and
numbers of the acidophilic iron- and sulfur-oxidizing bacterium
Thiobacillus ferrooxidans . The pH of the streams varied from
6.3 to 8.6 and the streams were nearly saturated with dissolved
oxygen. T. ferrooxidans  was found in eight of nine streams
affected by gold-mine drainage and in only one of 26 streams not
affected by gold-mine drainage. Some of the streams affected by
gold-mine drainage near Fairbanks, Alaska, occasionally
contained levels of dissolved arsenic above 50 parts per
billion. The recognition that T. ferrooxidans  is associated
with gold-mine material and that the heavy metal arsenic exists
in streams affected by gold-mine wastes is important for
understanding the environmental effects of mining activity on
subarctic streams.

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RANK =      2               - CL SYSTEMS LIMITED -         D= 124707  ASF

TITLE:                  Oxidation of ferrous iron by acidophilic iron-
                        oxidizing bacteria from a stream receiving
                        acid mine drainage.
AUTHOR/AFFIL:           Noike, T.;Nakamura, K.;Matsumoto, J. (Dep.
                        Civil Eng., Tohoku Univ., Sendai 980, Japan)
PUBLICATION:            WATER RES.

                        vol. 17, no. 1, pp. 21-28
                        (1983).
                        JOURNAL ARTICLE
LANGUAGE: En;en.
ASFA  1, 13(02), 1983  ABSTRACT NO 02132
SUBJECT SECTION:  (1)503, (1)201, (2)445
KEYWORDS:               oxidation; mines; drainage water; iron;
                        bacteria;
                        Japan, Aka R.
AQUATIC ENVIRONMENT:  FRESHWATER
      ABSTRACT:  In this study, the oxidation of ferrous iron
by the acidophilic iron-oxidizing bacteria was investigated by
field survey (Aka River, Japan) and laboratory-scale batch and
continuous experiments. The activity of the acidophilic iron-
oxidizing bacteria was affected by pH, water temperature and
concentration of glucose. The rate of oxidation of pyrite was
accelerated by the acidophilic iron-oxidizing bacteria. The
number of bacteria attached to the surface of a rotating
biological disk changed with the ferrous iron loading.

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RANK =      3               - CL SYSTEMS LIMITED -         D= 114260  ASF

TITLE:                  Comparative Limnology and Biota of Mine Spoils
                        Ponds in Colorado.
AUTHOR/AFFIL:           Canton, S.P. (Harner-White Ecol. Consultants,
                        4901 E. Dry Creek Rd., Littleton, CO 80122,
                        USA)
PUBLICATION:            SOUTHWEST. NAT.
                        vol. 27, no. 1, pp. 33-42
                        (1982).
                        JOURNAL ARTICLE
LANGUAGE: En;en.
ASFA  1, 12(08), 1982  ABSTRACT NO 10203
SUBJECT SECTION:  (1)503, (2)445
KEYWORDS:               mining; ponds; water analysis (Chemical);
                        pollution effects; reclamation; recreational
                        waters; colonization;
                        USA, Colorado
AQUATIC ENVIRONMENT:  FRESHWATER
      ABSTRACT:  Physico-chemical and biotic parameters were
investigated from June 1977 to May 1978 in coal strip-mine ponds
in Colorado which differed in age and in the proportion of
drainage derived from the mine. There were no discernible
effects of mine drainage on temperature, dissolved oxygen,
hardness, pH, acidity, alkalinity, calcium, iron,
orthophosphate, or the organic content of the substrate. Total
dissolved solids, nitrate, and sulfate values were higher in the
spoils ponds than in the control pond. Net zooplankton abundance
was lowest in the youngest spoils pond, but the standing crop of
benthos exhibited a progressive decrease from the youngest

spoils pond to the control pond. Certain zooplanktonic and
benthic species were rare or absent in the youngest spoils pond.
Colonization phenomena (age and distance from a source of
colonizers) are postulated as responsible, in part, for the
faunal differences between ponds, although higher levels of
nitrate, sulfate, and TDS in the spoils ponds may provide
adverse conditions for certain species. If these data are
typical of the western energy region, they suggest the potential
for development of recreational lakes as a part of reclamation
practices.
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BANK = A = CI SYSTEMS LIMITED - D= 108938 ASF

TITLE: Geochemical Investigations on Fluvial
Sediments Contaminated by Tin-mine Tailings,
Cornwall, England.
AUTHOR/AFFIL: Yim, W.W.-S. (Dept. Geogr. Geol., Univ. Hong
Kong, Hong Kong)
PUBLICATION: ENVIRON. GEOL.
vol. 3, no. 5, pp. 245-256
(1981).
JOURNAL ARTICLE
LANGUAGE: Engl.
ASFA 1, 12(03), 1982 ABSTRACT NO 03738
SUBJECT SECTION: (1)503, (2)445
KEYWORDS: sediment pollution; industrial wastes; mining;
heavy metals; geochemical analysis;
ANE, British Isles, England Red R.
AQUATIC ENVIRONMENT: BRACKISH

ABSTRACT: Tin-mine tailings containing high concentrations of Sn, Cu, Zn, Fe, Pb, As, and W are discharged into the Red River of Cornwall, England and are then transported into St. Ives Bay under normal flow conditions. Most of the tin-bearing particles in the fluvial sediments are smaller than 170 um, but tin-bearing composite grains or mineral grains with tin interspersed in the crystal lattices also occur in coarser size fractions. Suspended sediment and sediment transported by saltation filtered from river water samples also showed high concentrations of metals although, in contrast to the bottom sediments, they vary within a narrow range. Distributions of Cu, Zn, Fe, As, and Pb in the filtered sediments probably are related to the physical and chemical behavior of their sulphide mineral during fluvial transportation.

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RANK = 5 - QL SYSTEMS LIMITED - C= 88638 ASF

TITLE: Selected heavy metals in sediments and biota
from desert streams of the Gila River drainage
(Arizona).

ADDENDA: 3. Annu. Symp. on Aquatic Toxicology; New
Orleans, LA (USA); 17 Oct 1978.

AUTHOR/AFFIL: Lewis, M.A. (Procter and Gamble Co., Environ.
Safety Dep., Ivorydale Tech. Cent., Cincinnati,
OH 45217, USA)

PUBLICATION: In: Aquatic toxicology. Proceedings of the
third annual symposium on aquatic toxicology,
held New Orleans, LA, 17-18 October 1978.
Eaton, J.G.; Parrish, P.R.; Hendricks, A.C.
(eds.).
American Soc. for Testing and Materials.
Philadelphia, PA (USA).
Publ. by: ASTM; Baltimore, MD (USA).
May 1980.
p. 191-204.
ASTM-STP-707.
Spec. Tech. Publ. Am. Soc. Test. Mater.
ECON - CHAPTER ARTICLE

LANGUAGE: En;en.
ASFA 1, 11(7), JUL 81: SUBJECT SECTION 503 ABSTRACT NO.
11154

KEYWORDS: sediment pollution, heavy metals, pollution
monitoring, bioaccumulation, freshwater
pollution, USA, Arizona

AQUATIC ENVIRONMENT: freshwater

ABSTRACT: The distribution and bioaccumulation of heavy metals in mine-polluted and nonpolluted desert streams was studied during 1975 and 1976. Heavy metal concentrations in reference streams were less than the detection limits; however, periodic input of mining and milling wastes increased the zinc, copper, manganese, and iron in receiving test streams to above this level. Copper and, to a lesser extent, manganese concentrations were higher in samples of sediment and biota collected from contaminated waters ($P < 0.05$). The copper concentration was 12 times higher in biota collected from metal-contaminated waters than an identical species collected from reference areas. Fish viscera, fish eggs, and eviscerated fish in mine-impacted streams also contained a higher copper content. In contrast, concentrations of iron, cadmium, lead, and mercury were similar in all samples. The distributions of copper, manganese, and iron in the trophic levels were similar; consumer organisms concentrated less metal than did the sediments of primary producers. An exception was zinc, which achieved its highest concentration in the middle trophic levels. Higher copper levels in fish tissue did not affect length-weight relationships or condition values ($P > 0.05$).

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TITLE: A preliminary report from a study on the environmental impact of pyrite mining and dressing in a mountain stream in Norway.

ADDENDA: (Presented at: 3. International Conference on Ephemeroptera; Winnipeg, Manitoba (Canada); 4 Jul 1979).

AUTHOR/AFFIL: Aanes, K.J. (Norwegian Inst. Water Res., Box 333, Blindern, Oslo 3, Norway)

PUBLICATION: In: Advances in Ephemeroptera biology.
Flannagan, J.F.; Marshall, K.E. (eds.)
Publ. by: Plenum Press; New York, NY (USA).
1980.
p. 419-442.
ISBN 0-306-40357-9.
BOOK - CHAPTER ARTICLE

LANGUAGE: En;de,es,fr.

ASFA 1, 10(12), DEC 80: SUBJECT SECTION 50A ABSTRACT NO. 18354

KEYWORDS: Norway, Folla R., mining, environmental impact, freshwater pollution, pollution indicators, Ephemeroptera, pollution effects, Insectaations, marine environmentsE,

AQUATIC ENVIRONMENT: freshwater

ABSTRACT: The mining, milling and processing of complex zinc and copper pyrite ores causes water pollution in some districts of Norway. To determine the effects of the wastewater from the mining and flotation process, and the acid mine drainage from an old, now exhausted pyrite mine, physical, chemical and biological investigations were performed in the Folla river during 1975-1976. The character of the stream is changed primarily by the inflow of sulphate, calcium and heavy metals. In addition to higher concentrations of a number of substances, increased sediment deposition occurs, which is most distinct in the upper regions, downstream from the tailings impoundment. The bottom fauna in the riffles, sampled by a Surber square foot sampler are qualitatively and quantitatively changed. Ephemeroptera, which seem to give the best picture of the pollution, are investigated at the species level. In this part of the stream the mayfly fauna is represented by 5 families and 14 species. The impact of mine drainage on the bottom fauna, particularly on the mayflies is discussed in relation to the physico-chemical parameters.

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BANK = 7 - QL SYSTEMS LIMITED - D= 64594 ASF

TITLE: A treatment of acid mine water using sulfate-reducing bacteria.

AUTHOR/AFFIL: Wakao, N.; Takahashi, T.; Sakurai, Y.; Shiota, H.
(Lab. Appl. Microbiol., Dep. Agric. Chem., Fac. Agric., Iwate Univ., Morioka 020, Japan)

PUBLICATION: J. Ferment. Technol.,
57(5), 445-452
(1979)
JOURNAL ARTICLE - ORIGINAL RESEARCH

LANGUAGE: En;en.
ASFA 1, 80(09), SEP 80: SUBJECT SECTION 505 ABSTRACT NO. 12740

KEYWORDS: mining, water pollution treatment, Bacteria, sulphur compounds, mines, wastewater, wastewater treatment, sulphate-reducing bacteria, treatment, leaching

AQUATIC ENVIRONMENT: freshwater

ABSTRACT: The possibility of using the bacterial sulphate reduction in a mixed bacterial population for a purging process of acid mine water, which was discharged from the abandoned Matsuo sulphur and iron sulphide mine (Iwate Prefecture), was studied in both batch and continuous flow systems. The acid mine water containing wood-dust (sawdust) was used as a basic culture medium. Vigorous sulphate reduction and neutralization of the acid mine water occurred in the batch cultures supplemented with an organic nutrient, either peptone, sodium formate, sodium lactate, or sodium pyruvate. Sulphate reduction evidently did not occur below pH 4 but started only when the pH of the culture rose to the range of 4-5.2, possibly through the acivity of other heterotrophic microflora. Neutralization of the acid mine water (pH 4) by sulphate reduction was also possible in the continuous flow system if organic nutrients usable by the bacteria were supplemented and the flow rate of effluent was properly controlled.

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RANK =       8              - CL SYSTEMS LIMITED  -         D=  61778  ASF

TITLE:                  A simplified stream model of acid mine
                        drainage effects.
AUTHOR/AFFIL:           Chadderton,R.A. (Dep. Civ. Eng., Pennsylvania
                        State Univ., University Park, PA 16802, USA)
PUBLICATION:            Water Resour. Bull.,
                        15(4), 1159-1167
                        (1979)
                        JOURNAL ARTICLE - ORIGINAL RESEARCH
LANGUAGE: En;en.
ASFA  1, 80(08), AUG 80: SUBJECT SECTION 502     ABSTRACT NO.
                        10690
KEYWORDS:               mining, water quality, acidity, drainage
                        water, mathematical models
AQUATIC ENVIRONMENT:  freshwater
          ABSTRACT:     Three methods of modelling acid mine drainage

effects are discussed. A net alkalinity routing model is the
simplest of these, but can be potentially misleading. It
typically overestimates the effect of acid sources on pH by
neglecting carbon dioxide transfer to the atmosphere. Inclusion
of a simple carbon dioxide transfer function can substantially
reduce errors in stream quality prediction. A plug flow
reaeration equation, coupled with mass balancing at mixing
points in a stream network provides modelling results comparable
to those of more complex computerized solutions of chemical
equilibrium equations. None of the models accounts for carbonate
dissolution or oxidation and hydrolysis of ferrous iron.


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BANK =       9              - CL SYSTEMS LIMITED -          D=  55867  ASF

TITLE:                  The stream environment and macroinvertetrate
                        communities: contrasting effects of mining in
                        Colorado and the eastern United States.
ADDENDA:                (Presented at: Symposium on energy and
                        environmental stress in aquatic systems;
                        Augusta, Georgia (USA); 2 Nov 1977).
AUTHOR/AFFIL:           Ward,J.V.; Canton,S.P.; Gray,L.J. (Dep. Zool.,
                        Colorado State Univ., Fort Collins, CO 80521,
                        USA)
PUBLICATION:            In: Energy and environmental stress in aquatic
                        systems.
                        Thorp,J.H.; Gibbons,J.W.
                        Publ. by: Technical Information Center, US
                        Dep. Energy; Oak Ridge, TN (USA).
                        1978.
                        p. 176-187
                        DOE Symp. Ser.,
                        (no. 48)
                        BOOK - CHAPTER ARTICLE
LANGUAGE: En;en.
ASFA  1, 80(05), MAY 80: SUBJECT SECTION 504      ABSTRACT NO.
                        06361
KEYWORDS:               mineral industry, benthos, pollution effects,
                        community composition, chemical pollutants,
                        USA, mineral resources, mining, environments,
                        drainage, invertebrates, water pollution
AQUATIC ENVIRONMENT:  freshwater
        ABSTRACT:  Studies were conducted year-round on a
Colorado stream that receives drainage from a coal mine to
assess the potential response of macroinvertetrate communites to
mining activities in the western United States. Species
composition, diversity, and standing crop were examined, and
results are compared with similar studies conducted in eastern
states. Generally low values of sulfate and iron, highly-
buffered waters, and low levels of toxic substances
characterized the Colorado stream and aplied, in general, to

many streams in the western energy-development region. Moderate
inputs of soluble salts increased abundance of
macroinvertebrates without significant changes in community
structure or other discernible indications of stressed
conditions. This is attributed to the relatively soft waters
above the mine and the protection afforded by a buffer strip
between the mine spoils and the stream. Increased salinity,
sedimentation, and water depletion are major problems, but, with
proper environmental considerations, mining in the West may not
have the severe impact on stream biota which characterize many
eastern mining regions.

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BANK =      10              - QL SYSTEMS LIMITED -         D=  54084  ASF

TITLE:                  Heavy metals in acid streams from lignite
                        mining areas.
AUTHOR/AFFIL:           Rasmussen,L.; Sand-Jensen,K. (Lab. Environ.
                        Sci. Ecol., Tech. Univ. Denmark, Build. 224,
                        DK-2800 Lyngby, Denmark)
PUBLICATION:            Sci. Total Environ.,
                        12(1), 61-74
                        (1979)
                        JOURNAL ARTICLE - ORIGINAL RESEARCH

LANGUAGE: En;en.
ASFA  1, 80(04), APB 80: SUBJECT SECTION 503     ABSTRACT NO.
                        04927
KEYWORDS:               rivers, freshwater pollution, pollution
                        sources, coal, mines, Denmark, heavy metals,
                        mineral industry, industrial wastes, acidity,
                        aquatic plants, pollution effects
AQUATIC ENVIRONMENT:  freshwater
        ABSTRACT:  The drainage water from 3 abandoned lignite
mining fields (Haunstrup, Soby, and Skraestrup) in central
Jutland, Denmark is extremely acid (pH, 2.4-4.4), and the
concentrations of heavy metals are markedly elevated compared
with background levels and with concentrations in 2 regenerated
lignite pits (Karstoft, Br. Vium). Iron occurs with the highest
concentrations in the drainage water and the concentrations of
the other elements are in the order Mn)Zn)Ni)Pb)Cu)V)Cr and )Cd.
Concentrations of all analysed elements decline downstream from
the mining areas. The mining areas in the river Skjern system
have only a local effect on concentrations of heavy metals. The
export of heavy metals from the lignite mining areas compared
with the transport in the river Skjern is about 31% for Fe, 24%
for Zn, 18% for Mn, 13% for Ni, and (10% for the other elements.
Treatment of the drainage water from Haunstrup with lime has
halved the export of Fe and increased the pH from about 3.0 to
4.0, whereas the concentrations of Cd, Cr, Cu, Mn, Ni, and Zn
have remained almost unchanged. The diversity of submerged
macrophytes is very low in the acidic water near the mining

areas. High acidity, high levels of heavy metals and low
alkalinity are associated, and all may play a role in
suppressing the macrophyte flora.

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BASE =     11            - CL SYSTEMS LIMITED -          D=  28051  ASF
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TITLE:                 Impact of mine drainage on a mountain stream
                       in Pennsylvania.
AUTHOR/AFFIL:          Letterman,R.D.; Mitsch,W.J. (Dep. Civil Eng.,
                       Syracuse University, Syracuse, NY 13210, USA)
PUBLICATION:           Environ. Pollut.,
                       17(1), 53-73
                       (1978)
                       JOURNAL ARTICLE - ORIGINAL RESEARCH
LANGUAGE: En;en.
ASFA  1, 79(03), MAR 79: SUBJECT SECTION 504     ABSTRACT NO.
                       08418
KEYWORDS:              acidity, pollution effects, USA, Pennsylvania,
                       Inland Waters, benthos, freshwater fish,
                       industrial wastes, mines, streams, aquatic
                       animals, freshwater pollution
AQUATIC ENVIRONMENT:  freshwater
       ABSTRACT:  Physicochemical parameters and fish and
benthic macroinvertebrate community structure were studied in a
small mountain stream in western Pennsylvania. Sampling stations
were located upstream and downstream of coal mine drainage in an
otherwise unpolluted stream. Due to an alkaline discharge and
significant upstream alkalinity the pH below the mine discharges
remained between 6.5 and 8. The major factor affecting the
benthic community and fish population appeared to be ferric
hydroxide deposition. Rates of deposition during dry-weather
conditions ranged from 3 g m sup 2 day near the discharges to
0.01 g m sup 2 day at the downstream end of the study site. The
biomass of macroinvertebrates decreased from approx 14 g wet wt
m sup 2 above the discharges to 0.1-1.5 g wet wt m sup 2 within
the area of iron deposition. Invertebrate diversity decreased
significantly at the discharge but recovered to 75% of upstream
values. The low but constant-temperature discharge from the mine
may have enh[illegible]ed the diversity recovery. The standing crop of
fish decr[illegible]om approx 228 to 11 kg ha. Benthic fishes such
as scu[illegible]ckers were the groups most affected.

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TITLE: The effect of the iron ore tailings on the coastal environment of Tolo Harbour, Hong Kong.

AUTHOR/AFFIL: Wong, M.H.; Chan, K.C.; Choy, C.K. (Dep. Biol., Chinese Univ. Hong Kong, Shatin, New Territories, Hong Kong)

PUBLICATION: Environ. Res.,
15(3), 342-356
(1978)
JOURNAL ARTICLE - ORIGINAL RESEARCH
LANGUAGE: Engl.
ASFA 1, 79(G2), FEB 79: SUBJECT SECTION 504 ABSTRACT NO. 03162
KEYWORDS: iron, mines, wastes, pollution effects, coastal environments, ISEW, Hong Kong, marine pollution
AQUATIC ENVIRONMENT: marine

ABSTRACT: The effect of iron ore tailings on the coastal environment of Ma On Shan, Hong Kong was studied. The iron ore tailings have been dumped along the coast of Tolo Harbour since 1906 from an iron ore mine. Pollutants with a high concentration of various heavy metals together with the effect of land-filling activities recently created conditions detrimental to the already poorly flushed and domestically polluted inland sea in places such as Tolo Harbour. The physical, chemical, and biological parameters of the polluted area were studied. Transects were run downshore and the number of species and the number of individuals were recorded in the field, and edaphic and water analyses were carried out in the laboratory. The animal diversity in the polluted areas varied according to the type of deposited materials and the time of deposition. In general, the number of animals was low compared with the other sites not under the influence of the tailings. Crustaceans and bivalves were the dominant organisms and other organisms were absent in the polluted area, possibly due to the presence of heavy metals and the large amount of fine material deposited. Higher levels of iron, zinc, manganese, and copper were detected in the tissue of the most dominant species, Scopimera intermedia.

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BASE =      13          - QL SYSTEMS LIMITED -        D=  26404  ASF

TITLE:              The water quality of some coal mine effluents
                    and their effect on stream benthos and fish.
AUTHOR:             Radford, D.S.; Graveland, D.N.
AFFILIATION:        Department of Recreation, Parks and Wildlife,
                    Lethbridge, Alta. (Canada). Fish and Wildlife
                    Division
PUBLICATION:        Jan 1978
                    69 p.

                    Fish. Pollut. Rep. Fish Wildl. Div. (Alta.),
                    (no. 4)
                    REPORT (MONOGRAPHIC)
LANGUAGE: En;en.
ASFA  1, 79(02), FEB 79; SUBJECT SECTION 508     ABSTRACT NO.
                    03154
KEYWORDS:           water quality, industrial wastes, pollution
                    effects, benthos, bioassays, heavy metals,
                    game fish, ponds, rivers, water analysis
                    (chemical), Salmo gairdneri, Canada,
                    Alberta
AQUATIC ENVIRONMENT:  freshwater
        ABSTRACT:  During 1971-72 an investigation of water
quality of some coal mine effluents of abandoned and operational
mines in the Crowsnest Pass area of Alberta, and their effect on
stream benthos and fish was undertaken. Data was collected on
water chemistry and seasonal data on water temperatures recorded
in several areas. pH generally exceeds 7.0. Iron is the most
critical ion. Copper, manganese, lead, and zinc occur in some
effluents exceeding maximum recommended tolerable water
standards. Average electrical conductivity varied from 436-2638
micromhos cm. Major cations and anions are calcium, magnesium,
sodium, and bicarbonates and sulfates, respectively. Average
turbidity varied from 3.8-165 JTU. Water temperature of
effluents fluctuated little on daily and or seasonal bases and
was not correlated with elevation. Artificial and natural
settling ponds reduced content of total iron. Average standing
crops of stream insects downstream of three discharges were
reduced compared to upstream densities; the most pronounced
reductions occurred in small tributary streams. Standing crops
of Ephemeroptera, Plecoptera, and Trichoptera were reduced.
Bioassays of effluents at three sites indicated no toxicity to
rainbow trout (Salmo gairdneri) under natural conditions. An
analysis of heavy metal contamination of fish in effluent-
affected streams showed higher concentrations of most metals
than found in fish collected from unaffected waters, but the
difference was not great. Observations on metal contents
measured in sport fish are described. Concentrations of copper,
lead and zinc found in samples of fish did not exceed the
tolerance levels established by the Federal Food and Drug
Directorate for consumption.

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RANK = 14 - CL SYSTEMS LIMITED - D= 23848 ASF

TITLE: A survey of the macrofauna of a coal-waste polluted Lancashire fluvial system.

AUTHOR/AFFIL: Greenfield, J.P.; Ireland, M.P. (Dep. Zool., Univ. College of Wales, Aberystwyth, Dyfed, Wales)

PUBLICATION: Environ. Pollut.,

16(2), 105-122
(1978)
JOURNAL ARTICLE - ORIGINAL RESEARCH

LANGUAGE: En;en.
ASFA 1, 79(01), JAN 79: SUBJECT SECTION 504 ABSTRACT NO. 01417

KEYWORDS: freshwater pollution, iron, compounds, aquatic communities, Cottus gobio, Phoxinus phoxinus, Gasterosteus aculeatus, Noemacheilus barbatulus, British Isles, Lancashire, Inland Waters, mineral industry, pollution effects, industrial pollution, water pollution, mines, fish, iron, effects on

AQUATIC ENVIRONMENT: freshwater

ABSTRACT: The effect of coal mine spoils in the Burnley area of Lancashire on the pollution of adjacent rivers was investigated from 1974 to 1975. Areas of the rivers studied showed heavy deposits containing iron hydroxide which blanketed the substratum. The macroinvertebrate community above the site of pollution showed a high diversity and included oligochaetes, plecopterans, ephemeropterans, trichopterans, coleopterans, dipterans and a few molluscs. At the site of deposition of iron compounds there was a reduction in diversity to oligochaetes and the larvae of chironomids. The blanketing effect of the iron compounds seemed to be the most important factor in this depletion. Four species of fish were found above the site of pollution: bullhead (Cottus gobio), minnow (Phoxinus phoxinus), stickleback (Gasterosteus aculeatus) and stoneloach (Noemacheilus barbatulus). At the site of moderate pollution minnows and bullheads were no longer found and in the area of heavy pollution no fish were taken. Caging experiments indicate that physical pollution was the limiting factor. There was no subsequent recovery of C. gobio and P. phoxinus downstream of the source of heavy pollution and G. aculeatus and N. barbatulus only appeared after the polluted river was joined by the River Calder. The macroinvertebrate community showed signs of some recovery.

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BANK = 15 - QL SYSTEMS LIMITED - D= 23757 ASF

TITLE: A summary of possible environmental effects of disposing mine tailings into Strathcona Sound, Baffin Island.

AUTHOR/AFFIL: Hatfield, C.T.; Williams, G.L. (Hatfield Consulting Ltd., 4394 Gallant Ave., North Vancouver, BC V7G 1L, Canada)

PUBLICATION: 1976.
76 p.
ALUR 75-76-38
Rep. Dep. Indian Affairs Northern Devel.

Canada
REPORT (MONOGRAPHIC)

LANGUAGE: En;en.
ASFA 1, 79(01), JAN 79: SUBJECT SECTION 503 ABSTRACT NO. 01326

KEYWORDS: PNB, Canada, Baffin I., Strathcona Sound, pollution effects, heavy metals, industrial wastes, waste disposal, toxicity, bioaccumulation, mining, environmental surveys, fjords, dynamics

AQUATIC ENVIRONMENT: marine

ABSTRACT: This report is a 'desk' evaluation of the possible effects on the marine environment of disposing tailings into the sea from the Nanisivik Mine being developed on Strathcona Sound, Baffin Island. It is not an environmental impact study, but rather a summary of information on what is known to date about the environment at the site, the use local people make of it, and the effects of heavy metal pollution on living systems. The mine is to produce tailings containing zinc, lead, cadmium, copper, iron and arsenic. It is proposed to pipe the tailings to deep waters of the Sound for disposal because the extremely steep terrain and permafrost in the area make construction of conventional tailings lagoons difficult and costly. Heavy metals have relatively high toxicities to the living environment and generally bioaccumulate in animals. Cadmium, arsenic, lead and zinc in particular, affect marine life by directly killing the organisms or in some cases contaminating the animals to levels which make their flesh unfit for human consumption. Information from mines having marine disposal systems in Greenland and Vancouver Island is summarized. On the basis of present local environmental data on the area and scientific data on heavy metal pollution it is concluded that the tailings will probably contaminate the living environment in the area with heavy metals to significant levels if they are put into Strathcona Sound. Food sources for local people in the area could also be adversely affected. On the basis of the present level of information on the biological and physical dynamics of the fjord, scientific knowledge of the long-term effects of heavy metals on the living environment, and probable dangers of cadmium bioaccumulation in local marine life and man, it is concluded that the mine tailings should not be deposited into Strathcona Sound. Possible alternate solutions for the disposal of tailings from the mine are outlined and recommendations for further studies listed.

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BANK = 16 - QL SYSTEMS LIMITED - D= 13081 ASF

TITLE: Potential toxicity of taconite tailings to aquatic life in Lake Superior.

AUTHOR/AFFIL: Czterry, J.B.; Doudoroff, P.; Anderson, E.W.

(Reserve Mining Co., Silver Bay, MN 55614, USA)

PUBLICATION: J. Water Pollut. Control Fed., 50(2), 240-251 (1978)

LANGUAGE: En;de,en,es,fr

ASFA 1, 78(08), AUG 78: SUBJECT SECTION 504 ABSTRACT NO. 09712

KEYWORDS: toxicity, mines, industrial effluents, taconite, aquatic animals, America, Superior L., fish, industrial wastes, marine organisms, absence

AQUATIC ENVIRONMENT: freshwater

ABSTRACT: Reserve Mining Company's tailings launder effluent, a slurry of taconite tailings in Lake Superior water, was tested for toxicity to fish and invertebrates, usually after partial clarification by sedimentation. No toxicity was demonstrated by tests lasting 22 to 49 days when juvenile salmonids and perch were used, 84 to 119 days when salmonid embryos and larvae were used, and 98 to 363 days when Lake Superior amphipods or mysids, important fish foods, were the test animals. Some clarified, partially neutralized solutions made by suspending taconite tailings in acidified lake water proved acutely toxic to rainbow trout, presumably because of their dissolved iron content. However, the trout were not visibly affected after 4-day exposure to such daily replaced solutions whose pH was raised from 5.0-5.5 to 6.9 about 1 day before introduction of fish. Under no conceivable circumstances, the authors conclude, could the somewhat alkaline Lake Superior waters be rendered even slightly toxic to fish by dissolution of taconite tailings settling to the lake bottom.

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RANK = 17 - CL SYSTEMS LIMITED - D= 4175 ASF

TITLE: Acid mine drainage (AMD) and its impact on a
small Virginia stream.
AUTHOR/AFFIL: Hoehn, R.C.; Sizemore, D.R. (Dep. Civil Eng.,
Virginia Polytech. Inst. and State Univ.,
Blacksburg, VA 24060, USA)
PUBLICATION: Water Resour. Bull.,
13(1), 153-160
(1977)
LANGUAGE: En;en.
ASFA 1, 78(03), MAR 78: SUBJECT SECTION 504 ABSTRACT NO.
03153
KEYWORDS: industrial wastes, benthos, toxicity,
bioassays, water analysis, pollution effects,
USA, Virginia, Chestnut Creek, acidity,
industrial effluents, mines
AQUATIC ENVIRONMENT: freshwater

ABSTRACT: A study was conducted to (1) chemically characterize 3 AMD streams entering Chestnut Creek in southwestern Virginia below the town of Galax, Virginia, and (2) to assess the biological and chemical alterations in the creek. Over a 6 mile reach, the benthic macroinvertebrate population was reduced to zero, the naturally low alkalinity (approx 25 mg l) of the stream was reduced to less than 5 mg l, and the pH was reduced from 7.2 to 6.3. Increased concentration of iron from less than 0.01 mg l to more than 4.0 mg l were accompanied by the deposition of a coating of iron hydroxide up to 0.25 in. thick in the stream bed, a phenomenon most likely responsible for the absence of benthic macroinvertebrates. In situ bioassays with bluegill sunfish and one snail species showed that the creek water, after confluence with all the AMD streams, was not toxic in 152 h to fish, and snails survived 96 h before they began to die. The undiluted AMD itself was highly toxic.

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RANK = 18 - CL SYSTEMS LIMITED - D= 12749 ASF

TITLE: Metals in an acid mine stream and estuary.
AUTHOR/AFFIL: Foster, P.; Hunt, D.T.E.; Morris, A.W. (Mar.
Sci. Lab., Menai Bridge, Gwynedd, UK)
PUBLICATION: Sci. Total Environ.
9(1), 75-86
(1978)
LANGUAGE: En;en.
ASFA 2, 78(07), JUL 78: SUBJECT SECTION 443 ABSTRACT NO.
05325
KEYWORDS: freshwater pollution, sediment polln, metals,
runoff, mining, iron, zinc, copper, manganese,
rivers, estuaries, British Isles, Wales,
Gwynedd, Goch R., brackishwater pollution,
pollution monitoring, pollution levels, acids,
mines, streams
AQUATIC ENVIRONMENT: brackish freshwater

ABSTRACT: Data on the concentrations of selected metals in the waters and sediments of an acid mine stream and its estuary are reported. The river water at the mouth is enriched in zinc, copper and manganese by at least two orders of magnitude above normal river water concentrations after having been significantly diluted by non-metalliferous tributaries. Iron is precipitated along the length of the stream while losses of copper and zinc from solution occur by adsorption onto hydrated ferric oxide above pH values of 4.5 and 6, respectively. Manganese concentrations are affected solely by dilution. The dissipation of the metalliferous river water in the marine regime is restricted, giving rise to estuarine waters containing high concentrations of copper and zinc both in solution and hydrogenous suspension. Deposition of hydrogenous material within the estuary is small, but approximately 50% of the zinc and 90% of the copper in the sediment is in a potentially mobile form. The environment is an unsuitable habitat for all but a few organisms.

BASE = 19 - CL SYSTEMS LIMITED - D= 11582 ASF

TITLE: The impact of taconite tailings on dissolved solids concentrations in Lake Superior.

ADDENDA: (Presented at: Interactions between sediments and fresh water (international symposium): Amsterdam (Netherlands); 6 Sep 1976).

AUTHOR/AFFIL: Plumb, R.H., Jr. (US Army Corps Engineers Waterways Exp. Sta., MS, USA)

PUBLICATION: In: Interactions between sediments and fresh water
Golterman, H.L. (ed.)
Publ.by: Dr. W. Junk B.V.; The Hague (Netherlands) Center for Agricultural Publishing and Documentation, Wageningen (Netherlands)
1977
p.423-433

LANGUAGE: Engl.

ASFA 1, 78(07), JUL 78: SUBJECT SECTION 503 ABSTRACT NO. 08208

KEYWORDS: America, Superior L., mineral industry, industrial wastes, alkalinity, environmental effects, suspended matter, interstitial water, sediment-water interface, sediment transport

AQUATIC ENVIRONMENT: freshwater

ABSTRACT: An iron ore mining beneficiation plant discharges approx 60,000 metric tons per day of taconite tailings (finely divided crushed rock) to Lake Superior. These tailings are composed primarily of quartz and an amphibole cummingtonite, a few percent iron minerals and other trace minerals. Several years leaching tests have shown that taconite tailings solubility ranges from 0.03 to 1.2%, with the latter figure representing the maximum possible release under laboratory conditions simulating the Lake Superior environment. Under these conditions the alkalinity in the lake might increase up to 2 mg l after 50 yr discharge. The total dissolved solids content of the lake is in the order of 57 mg l. The maximum expected increase in dissolved solids after 50 yr of operation would be in the order of 3 mg l. These computations assume that all dissolved solids added to the lake are conservative, i.e., remain in solution and are only removed by outflow from the lake with no incorporation into the sediments. A field study demonstrated that the concentrations of various major dissolved solids in the interstitial waters where taconite tailings have been deposited previously were elevated above the concentrations in areas where there had been no taconite tailings deposited. However, measurements immediately above the sediment-water interface showed that the rate of transport from the sediments to the overlying waters was sufficiently slow so that there was no detectable change in the concentrations of dissolved solids in the areas where the sediments were covered with taconite tailings compared to non-tailings area. It is concluded that past and future discharges of taconite tailings would have no significant impact on dissolved solids concentrations in Lake Superior.

TITLE: Peroxide oxidation of iron in coal mine drainage.

AUTHOR/AFFIL: Cole, C.A.; Molinski, A.E.; Rieg, N.; Backus, F. (Address not stated)

PUBLICATION: J. Water Pollut. Control Fed., 49(7), 1616-1620 (1977)

LANGUAGE: En;en.
ASFA 1, 78(06), JUN 78: SUBJECT SECTION 505 ABSTRACT NO. 07188

KEYWORDS: water pollution treatment, artificial aerati, iron, oxidation, USA, Pennsylvania, Wildwood, alkalinity, water pollution

AQUATIC ENVIRONMENT: freshwater

ABSTRACT: Ferrous iron in a coal mine drainage water at Wildwood, Pennsylvania, was found to be oxidizing and precipitating in a small receiving stream. A cascade aeration system and a 3 000-m sup 3 cement settling basin were installed in an effort to remove the iron from the nearly all 400 m sup 3 d flow but were only partially successful. Of the 30 to 40 mg l of iron entering the system, as much as 25 mg l was escaping into the stream and about half of this was unoxidized. Hydrogen peroxide was investigated at the site as an oxidant to increase the iron oxidation and enhance precipitation. The stoichiometric requirement of hydrogen peroxide to iron is 1:3.3 in acid or neutral solutions. The oxidized iron then reacts with the alkalinity in water to precipitate as ferric hydroxide. A permanent installation is now producing an effluent of <1 mg l of total iron with 7 mg l of peroxide.

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RANK = 21 - CL SYSTEMS LIMITED - D= 87124 ASF

TITLE: Chemistry and mineralogy of Precambrian paleosols at Elliot Lake, Ontario, Canada.

AUTHOR/AFFIL: Gay,A.L.; Grandstaff,D.E. (Gulf Sci. Technol., 11111 Hilcrest Drive, Houston, TX 77099, USA)

PUBLICATION: Precambrian Res.,
12(1-4), 349-373
(1980)
JOURNAL ARTICLE - ORIGINAL RESEARCH

LANGUAGE: En;en.
ASFA 2, 11(6), JUN 81*: SUBJECT SECTION 187 ABSTRACT NO. 06859

KEYWORDS: chemical composition, mineralogy, Canada, Ontario, Elliot L., Precambrian period, trace metals, sediments

ABSTRACT: Two profiles from the paleosol underlying the Huronian Supergroup at Elliot Lake, Ontario were studied to determine conditions present at the time of their formation. (1) One paleosol profile ()10.5 m thick), developed on greenstone, is exposed within the Denison Mine. It is tentatively classified as an intrazonal gley soil formed in an area of poor drainage and reducing groundwater conditions. It is characterized by extensive loss of Fe, Mn, Cu, Ni, and Mo, as well as Na, Ca, and Mg. An increase in K is attributed to diagenetic K metasomatism. Paleosol structures indicate clay translocation forming an illuvial B sub g horizon and suggests a fluctuating water table to depths of 6m. (2) The second paleosol profile ()5.5 m thick), developed on granite, is exposed near the Pronto Mine. This profile exhibits iron oxidation and enrichment. This indicates that free oxygen was present in the mid-Precambrian atmosphere, although a precise determination of pO sub 2 is not possible from evidence from the paleosols. This paleosol exhibits many characteristics of modern spodosols. The soils probably formed in a temperate humid climate during tectonically stable conditions. The difference in oxidation and behavior of iron in these soils is inferred to result from differences in paleotopography and drainage. The preponderance of gley paleosols found underlying the Huronian Supergroup might result either from lower mid-Precambrian oF sub 2 or from preferential preservation. Evidence suggests that by 2.3 Ga ago, soil forming processes were capable of producing soils similar to Recent types.

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BANK =      22                - QL SYSTEMS LIMITED -          D= 44627  ASF

TITLE:                   Black water and two peculiar types of
                         stratification in an organically loaded strip-
                         mine lake.
AUTHOR/AFFIL:            Stahl,J.B. (Dep. Zool., Southern Illinois
                         Univ., Carbondale, IL 62901, USA)
PUBLICATION:             Water Res.,

                         13(5), 467-471
                         (1979)
                         JOURNAL ARTICLE - ORIGINAL RESEARCH
LANGUAGE: En;en.
ASFA  1, 79(12), DEC 79; SUBJECT SECTION 145      ABSTRACT NO.
                         15435
KEYWORDS:                lakes, water properties, stratification, water
                         colour, USA, Illinois, anoxic conditions
AQUATIC ENVIRONMENT:  freshwater
        ABSTRACT:  During summer stratification a strip-mine lake
in which fish were cultured in floating cages developed black
water in its anoxic zone. The blackness was evidently produced
by ferrous sulfide. Two types of black water stratification were
observed. In one the blackness occurred throughout the anoxic
zone but was more intense in the upper part, while iron and
alkalinity were high throughout this zone. In the second the
black water was confined to a meter-thick stratum within the
anoxic zone, and iron and alkalinity were remarkably low except
in two strata: the one with black water, and the one at the top
of the anoxic zone. It is suggested that both types of
stratification were caused by a high rate of sulfide production
in the metalimnion. The relatively high temperature there (as
compared to the hypolimnion) and the presumably higher
concentrations of organic matter and ammonia, resulting from
fish food and fish wastes, would account for this high rate of
sulfide production. Because of sharp oxygen stratification two
carbonate-forming processes, photosynthesis and sulfate
reduction, occurred in close proximity to each other. In
especially calm weather vertical density currents could be
initiated by the calcium carbonate crystals and produce the
second type of stratification. If the second type of
stratification could be produced at will it might be used to
improve the quality of strip-mine lake water.

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RANK =      23            - CL SYSTEMS LIMITED -          D= 114776  ASF

TITLE:               Copper Pollution Studies in Lakes George and
                     Edward, Uganda: The Distribution of Cu, Cd and
                     Fe in the Water and Sediments.
AUTHOR/AFFIL:        Bugenyi, F.W.B. (Uganda Freshwater Fish. Res.
                     Organ., P.O. Box 343, Jinja, Uganda)
PUBLICATION:         ENVIRON. POLLUT. SER. B.
                     vol. 3, no. 2, pp. 129-138
                     (1982).
                     JOURNAL ARTICLE
LANGUAGE: En;en.
ASFA  1, 12(09), 1982  ABSTRACT NO 11362
SUBJECT SECTION:     (1)503, (2)445
KEYWORDS:            baseline studies; heavy metals; copper;
                     cadmium; iron; freshwater lakes; pollution

                     surveys; mining; industrial wastes;
                     Uganda;
                     Uganda, George L.; Uganda, Edward L.
AQUATIC ENVIRONMENT:  FRESHWATER
       ABSTRACT:  The need for baseline data on heavy metal
pollution in general--and copper pollution in particular--of the
aquatic biota of lakes George and Edward, uganda, arose when it
was realised that the growing copper mining industry uses the
water system as a "natural sink" for mining waste products. A
study with a number of objectives was proposed, the first of
which is completed and reported here. The concentration levels
of the metals copper, iron and cadmium in each of the water
bodies do not show much variation, but are distinct in the
different water bodies, with Lake George having more Cu ions in
the water and surface sediment than Lake Edward, The latter has
more total dissolved organics than Lake George, and these play
an important role in influencing the concentration levels of the
trace metals.

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RANK =      24            - CL SYSTEMS LIMITED -          D= 127047  ASF

TITLE:               Effect of surface treatment of tailings on
                     effluent quality.
AUTHOR/AFFIL:        Murray, D.R.;Okuhara, D. (Elliot Lake Lab.,
                     Mining Res. Lab., Canada Cent. Mineral and
                     Energy Technol., Dep. Energy, Mines and
                     Resour., Elliot Lake, Ont., Canada)
PUBLICATION:         RECLAM. REV.
                     vol. 1, no. 3, pp. 169-177
                     (1980).
                     JOURNAL ARTICLE
LANGUAGE: En;en.
ASFA  1, 13(03), 1983  ABSTRACT NO 04105
SUBJECT SECTION:     (1)522, (2)444
KEYWORDS:            land reclamation; water quality; mineral
                     industry
AQUATIC ENVIRONMENT:  FRESHWATER
       ABSTRACT:  Successful reclamation treatment, in
preparation for long range abondonment of mining wastes,
involves both surface treatment and water quality control
containment of waste solids and liquid contaminants. This paper
describes use of lysimeters containing 125 tonnes of tailings to
determine the impact of gravel, sawdust and vegetation as
surface treatments on the quality and quantity of effluent
produced from sulphide containing uranium mill tailings.

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TITLE: Biological release and recycling of toxic metals from lake and river sediments.

AUTHOR/AFFIL: Nicholas, W.L.; Thomas, M. (Dep. Zool., Australian Natl. Univ., Canberra, 2600 ACT, Australia)

PUBLICATION: Aust. Water Resour. Counc. Tech., (no. 33), 1-99 (1978)

JOURNAL ARTICLE - ORIGINAL RESEARCH

LANGUAGE: En;en.

ASFA 1, 79(10), OCT 79: SUBJECT SECTION 482 ABSTRACT NO. 13788

KEYWORDS: Australia, New South Wales, Molonglo R., freshwater pollution, heavy metals, biogeochemical cycles, polluted environments, pollution effects

AQUATIC ENVIRONMENT: freshwater

ABSTRACT: The Molonglo River, NSW, Australia, has been polluted with heavy metal wastes from mines, now abandoned, on the banks of the river. Pollution has almost eliminated animals and plants from the river bed for many kilometres downstream. Great quantities of zinc are present in the river system. Organic detritus has firmly bound very high concentrations of zinc and animals and plants have very high concentrations of zinc in their tissues. Microbial films accumulated high concentrations of heavy metals and microscopic nodules rich in zinc and copper or iron, manganese, with lesser amounts of other metals have developed on substrates over several months. Bullrushes and willows take up zinc from the river sediments, and their dead leaves retain zinc until they disintegrate. Dead bullrush leaves continue to absorb zinc from the river water and from the river sediments. Microorganisms, predominately algae, also absorb zinc from river water and retain zinc in zinc-free water. Invertebrates feeding on the detritus and microorganisms ingest zinc in their food, retaining some in their tissues, but excrete much with their faeces.

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RANK =     26              - QL SYSTEMS LIMITED -          D=  14527  ASF

TITLE:              Kuroko deposits of the Kosaka Mine, northeast
                    Honshu, Japan _ products of submarine hot
                    springs on Miocene sea floor.
AUTHOR/AFFIL:       Urabe, T.; Sato, T. (Geol. Inst., Fac. Sci.,
                    Univ. Tokyo, 7-3-1 Hongo, Bunkyo-ku, Tokyo,
                    Japan)
PUBLICATION:        Econ. Geol.,
                    73(2), 161-179

                    (1978)
LANGUAGE: En;en.
ASFA  2, 78(08), AUG 78: SUBJECT SECTION 268     ABSTRACT NO.
                    05758
KEYWORDS:           submarine springs, hydrothermal activity,
                    Miocene epo, ocean floor, mineral resources,
                    Japan, Honshu
AQUATIC ENVIRONMENT:  marine
       ABSTRACT:  The Kosaka mine is a productive Cu-Pb-Zn-Au-Ag
mine in Japan and is located at the eastern margin of the
Hokuroku mining district in northeast Honshu Island. The ore
deposits of the mine are divided into three main groups from
north to south, namely, the Motoyama, Uchinotai, and Uwamuki ore
deposits. Each ore deposit has both massive stratiform and
underlying network or disseminated, siliceous orebodies. The
geologic features of each deposit are described. The iron
content of sphalerite coexisting with pyrite from the Uchinotai-
nishi and Uwamuki No. 4 ore deposits never exceeds 5 mole
percent FeS. The iron content of sphalerite from the latter and
two other Kuroko deposits decreases gradually upward from
stockwork to stratiform orebodies. This vertical zoning may be a
common feature of the Kuroko deposits although those from the
Uchinotai-nishi ore deposit show a minimum iron content at the
boundary between the black and yellow ore zones. Mixing of sea
water with the ascending hydrothermal solution causes an
increase in oxygen fugacity and a simultaneous temperature
decrease in the ore-forming environment. They are the main
causes of ore deposition. Deposition of barite is likely to be
the result of an increase in activity of metastable sulfate ions
which are added from sea water to the reducing ore-forming
system. A magmatic origin of the ore-forming fluid is also
proposed on the basis of fluid inclusion data and geologic
evidence.

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TITLE:               Heavy metals in the Fal Estuary, Cornwall: A
                     study of long-term contamination by mining
                     waste and its effects on estuarine organisms.
AUTHOR/AFFIL:        Bryan, G.W.;Gibbs, P.E. (Mar. Biol. Assoc.,
                     The Laboratory, Citadel Hill, Plymouth, PL1
                     2PB, UK)
PUBLICATION:         Publ. by: MARINE BIOLOGICAL ASSOCIATION OF THE
                     UK
                     PLYMOUTH (UK)
                     1983.
                     112 pp
                     ISSN: 0260-2784
                     OCCAS. PUBL. MAR. BIOL. ASSOC. U.K.
                     no. 2

                     REPORT
LANGUAGE: En;en.
ASFA  1, 13(C6), 1983  ABSTRACT NO 08664
SUBJECT SECTION:     (1)504, (2)445
KEYWORDS:            heavy metals; pollution effects; mining;
                     estuarine organisms;
                     Fucus vesiculosus; Nereis diversicolor;
                     Carcinus maenas; Scrobicularia plana;
                     Cerastoderma edule; Mytilus edulis; Littorina
                     littorea; Littorina littoralis;
                     ANE, British Isles, Fal Estuary, Restronguet
                     Creek;
                     arsenic; cadmium; copper; iron; manganese;
                     lead; zinc; nickel; cobalt; pollution
                     tolerance; ANE, British Isles, Fal Estuary;
                     British Isles, Carnon R.
AQUATIC ENVIRONMENT:  MARINE, BRACKISH
       ABSTRACT:  The Fal Estuary System in west Cornwall has,
over many centuries, received inputs of heavy metals from
various mining activities. Analyses of organisms from the Fal
Estuary have shown that some species contain abnormally high
concentrations of Cu, Zn and As, especially in those living in
Restronguet Creek. Tissue metal levels do not always reflect
those of the environment: there is good evidence that some
metals are regulated, including Zn, Cu, As, Mn and Fe, by
particular species. Experimental data indicate that the levels
of Cu, Zn and recently-precipitated Fe oxide in the waters and
sediments of Restronguet Creek would be expected to have a
detrimental effect on the biota. However, the flora and fauna is
less obviously affected than might be predicted from
experimental toxicity data. Several factors can be forwarded to
explain this anomaly: first, the development of Cu or Zn
tolerant strains which enable the species to establish breeding
populations, and second, the development of increased tolerance
with exposure to the conditions such as occurs when individuals
are carried by tidal currents into the Creek. Tolerant species
often contain high concentrations of metals; some of these
species form the major food element of some predators inhabiting
the Creek which thereby have high metal intakes.

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RANK = 28 - QL SYSTEMS LIMITED - D= 76025 ASF

TITLE: Biogeochemical mechanism of contamination of plants by lead, cadmium and zinc.

AUTHOR/AFFIL: Faucherre,J. (Univ. Paris 7, France)

PUBLICATION: In: Second environmental research programme, 1976-1980. Reports on research sponsored under the first phase: 1976-1978. (Indirect action). Commission of the European Communities, Brussels (Belgium). Directorate-General

Research, Science and Education, Environment and Raw Materials Research Programmes.
Publ. by: Commission of the European Communities; Luxembourg (Luxembourg).
1980.

p. 21-25.
ISBN 92-825-0456-4.
BOOK - CHAPTER ARTICLE

LANGUAGE: En.
ASFA 1, 11(02), FEB 80: SUBJECT SECTION 504 ABSTRACT NO. 02238

KEYWORDS: biogeochemical cycle, heavy metals, lead, cadmium, zinc, river water, iron, manganese, arsenic compounds, pollution effects, public health

AQUATIC ENVIRONMENT: freshwater

ABSTRACT: The pH and redox potential of polluted river water from washout by precipitation runoff over mining areas of galena, blende, and pyrite commonly found at the Triassic and Hettangian levels around the Massif Central were determined. Waters, soils (including interstitial waters) and plants were analyzed for AsO sub 2 sup -, Cd, Fe sup 2 sup +, Fe sup 3 sup +, Mn, Pb, and Zn using atomic absorption spectroscopy or polarography. A geochemical model was developed for the migration of Pb, Zn and Cd, and a survey undertaken to evaluate the effects on the number of children per family in the local population. Tree-rings from conifers were analyzed to reconstruct the last 70 yrs of the history of the pollution and microclimate.

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BANK =      23              - CL SYSTEMS LIMITED -          D=   8231  ASF

TITLE:                  Vegetating the uranium mine tailings at Elliot
                        Lake, Ontario.
AUTHOR/AFFIL:           Murray, D.; Moffett, D. (Elliot Lake Lab.,
                        Mining Res. Lab., Canada Cent. Mineral and
                        Energy Technol., Dep. Energy, Mines, and
                        Resour., Elliot Lake, Ontario P5A 2J6, Canada)
PUBLICATION:            J. Soil Water Conserv.,
                        32(4), 171-174
                        (1977)
LANGUAGE: En;en.
ASFA  1, 78(05), MAY 78: SUBJECT SECTION 522     ABSTRACT NO.
                        06063
KEYWORDS:               Canada, Ontario, Elliot L., pollution control,
                        industrial wastes, land reclamation, waste
                        disposal sites, mines, revegetation
AQUATIC ENVIRONMENT:  freshwater
        ABSTRACT:  The pyritic uranium tailings near Elliot Lake,
Ontario, were vegetated with a surface application of limestone

(2.24 kilograms square meter (10 tons acre)) to neutralize
acidity an fertilizers to compensate for the lack of nutrients
and a very low cation exchange capacity. This study involved no
supplemental organic matter or topsoil. The authors seeded 24
grasses, legumes, and annuals in field plots, 3 meters by 6
meters (10 feet x 20 feet). Six grasses and 3 legumes persisted
over 4 growing seasons. Species selection was based on herbage
yield, percent groundcover, and field observations. Reed canary
grass proved to be the most successful species, but a mixture of
creeping red fescue with redtop or Kentucky bluegrass seemed
preferable because of its superior soil-forming abilities.
Legumes performed so poorly that their incorporation in seed
mixtures is not recommended.

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TITLE: Environmental Research accompanying a deepsea mining project in the Red Sea.
ORIGINAL TITLE: Umweltuntersuchungen zu einem Tiefsee-Bergbau-Projekt im Roten Meer.
ADDENDA: (Presented at: Intermaritec '80, Hamburg. International Conference on Marine Sciences and Ocean Engineering; Hamburg (GFR); 1980).
AUTHOR/AFFIL: Backer,H.; Karbe,L. (Preussag AG, Hannover, GFR)
PUBLICATION: In: Intermaritec '80, Hamburg. International Conference on Marine Sciences and Ocean Engineering. Conference Report.
Intermaritec '80, Hamburg. International Kongress fuer Meeresforschung und Meerestechnik. Kongress-Berichtswerk.
Publ.by: Hamburg Messe und Congress; Hamburg (GFR).
1980.
p. 543-552
AINT 80-306
BOOK - CHAPTER ARTICLE
LANGUAGE: Ge;de,en.
ASFA 2, 11(12), DEC 81: SUBJECT SECTION 404 ABSTRACT NO. 10615
KEYWORDS: ISW, Red Sea, deep sea mining, metalliferous sediments, zinc, copper, silver, environmental impact
AQUATIC ENVIRONMENT: marine

ABSTRACT: Metalliferous muds containing appreciable amounts of zinc, copper and silver are formed in the Atlantis II Deep in 2,000 m water depth in the central trough of the Red Sea. To assess the economic potential of these occurrences and to develop the necessary new technology for their recovery the Saudi Sudanese Joint Commission for the Exploitation of the Red Sea Resources has set up a comprehensive research and development program. A through study of environmental implications of ocean mining in the Red Sea is an integral and important part of this program. The work includes baseline studies in the fields of chemical oceanography, plankton, deep benthos and reef communities, current measurements and eco-toxicological and diffusion tests. It is planned to separate the sulfide minerals of the valuable metals on board the mining ship by flotation methods and re-discharge the tailings through a pipe at depth. A first mining test in 1979 demonstrated the technical feasibility of such a procedure and provided the opportunity to monitor the spreading of the tailings from the discharge point at 400 m depth. The first results indicate that the tailings should be confined to the biologically little active waters of the deep Central Red Sea trough below 800 m, and that solid concentrations in the tailing plume outside the vicinity of the discharge jet should be kept below 10 mg per litre seawater.

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BANK =      31           - CL SYSTEMS LIMITED  -         D= 120733  ASF

TITLE:                  Heavy Metal Release from Mine Tailings into
                        Sea Water--A Laboratory Study.
AUTHOR/AFFIL:           Hoff, J.T.;Thompson, J.A.J.;Wong, C.S. (Ocean
                        Chem. Div., Inst. Ocean Sci., P.O. Box 6000,
                        Sidney, B.C., Canada, V8L 4B2)
PUBLICATION:            MAR. POLLUT. BULL.
                        vol. 13, no. 8, pp. 283-286
                        (1982).
                        JOURNAL ARTICLE
LANGUAGE: En;en.
ASFA  1, 12(12), 1982  ABSTRACT NO 15524
SUBJECT SECTION:        (1)503, (2)445
KEYWORDS:               heavy metals; mining; pollution monitoring;
                        coastal inlets;
                        simulation;
                        INE, Canada, British Columbia
AQUATIC ENVIRONMENT:  MARINE
       ABSTRACT:  In a laboratory experiment to simulate mine
tailings disposal into a coastal inlet of British Columbia,
initial rapid increases in dissolved iron, copper and lead were
observed in the first three hours with subsequent slow decreases
to background values within one month. Manganese and nickel
increased slowly during the experiment while cadmium and zinc
did not increase.

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BANK =      32           - CL SYSTEMS LIMITED  -         D=  74932  ASF

TITLE:                  On the hydrochemical situation of the open-pit
                        lakes in the Lausitz lignite area.
ORIGINAL TITLE:         Zur hydrochemischen Situation der Tagebauseen
                        des Lausitzer Braunkohlen-Revieres.
AUTHOR/AFFIL:           Pietsch, W. (DDR 8027 Dresden, Am Talchen 16,
                        GDR)
PUBLICATION:            Archiv. Naturschutz Landschaftsforsch.,
                        19(2), 97-115
                        (1979)
                        JOURNAL ARTICLE - ORIGINAL RESEARCH
LANGUAGE: De;de,en,ru.
ASFA  2, 11(01), JAN 80: SUBJECT SECTION 445     ABSTRACT NO.
                        00659
KEYWORDS:               freshwater lakes, mineral industry,
                        acidification, chemical composition, pH, iron,
                        calcium, sulphates, German Dem.Rep., Lausitz,
                        freshwater pollution
AQUATIC ENVIRONMENT:  freshwater
       ABSTRACT:  On the basis of 219 opencast lakes of the
Lusatian lignite-mine district the hydrochemical composition and
situation of the residue lakes are represented. More than half
of the opencast waters are distinguished by an extremely acidic
water reaction at pH-values from 2.5 to 4.0, involving large
quantities of free mineral acid, especially of free sulfuric
acid, and very high degrees of hardness caused by a high content
of sulphate. The waters are rich in total iron, calcium and
sulphate. Between the pH value and the content of free mineral
acid there is a positive relation of a non-linear course. But
there is a positive relation of a linear course between the free
mineral acid and the content of iron, calcium, sulphate and the
total hardness. The frequency distribution of the most important
hydrochemical factors was determined and displayed in form of
graphical representations. Three distinct accumulation centres
can be determined in the distribution of the most important
parameters. They are to observe in the low, middle and extremely
high range of concentration.

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RANK = 33 - QL SYSTEMS LIMITED - D= 43233 ASF

TITLE: Whose nodules are they
AUTHOR/AFFIL: Ford,G.; Gibbons,R. (Dep. Lib. Stud., Univ. Manchester, Manchester, UK)
PUBLICATION: New Scientist,
82(1156), 631-633
(1979)
JOURNAL ARTICLE - REPORT
LANGUAGE: En.

ASFA 2, 79(10), OCT 79: SUBJECT SECTION 408 ABSTRACT NO. 07871

KEYWORDS: ferromanganese nodules, Law of the Sea, mineral exploration, mineral industry, deep sea mining

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AQUATIC ENVIRONMENT: marine

ABSTRACT: A discussion of the political, economic, legal and technical issues involved in mining deep sea nodules containing manganese, iron copper, cobalt and nickel. The political and legal issues revolve around the United Nations Conference of the Law of the Sea, (UNCLOS), which has been attempting to reach some international agreement on exploitation. Economic problems are concerned with the cost of research and the fact that increases in the prices of the minerals would make it viable to mine certain land-based deposits. The main difficulties are technical. Although scaled-down mining equipment has been successfully tested no one has managed to recover nodules at a rate that when scaled-up would equal that envisaged during any commercial operation. There are also more specific technical problems: (1) mapping of mine sites must be very detailed because crossing bumps a few metres in size could damage collector heads, (2) resonances, flexing and bending can cause fatigue in the pipe, (3) the nodules will be transported in a slurry and all loose cargo with a high water content is liable to fluidise in certain sea conditions, and (4) the power requirements need to be reduced to make the operation economic.

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RANK =     34                - QL SYSTEMS LIMITED -         D=   8972  ASP
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TITLE:               The Campbell River estuary. Status of
                     environmental knowledge to 1977. Report of the
                     Estuary Working Group, Department of Fisheries
                     and the Environment, Regional Board Pacific
                     Region.
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AUTHOR/AFFIL:        Fisheries and Marine Service, West Vancouver,
                     B.C. (Canada). Pacific Environment Institute.
PUBLICATION:         1 Jul 1977.
                     346 p.
                     Spec. Estr. Ser. Environ. Can.,
                     (no. 7)
---------------------------------------------------------------------------
LANGUAGE: En.
ASFA  1, 78(06), JUN 78: SUBJECT SECTION 105      ABSTRACT NO.
                     06255
KEYWORDS:            environmental surveys, biological data,
                     pollution effects, geology, climate,
                     hydrology, oceanology, water quality,
                     estuaries, Salmonidae, INE, Canada, Vancouver
                     I., Campbell R. estuary
AQUATIC ENVIRONMENT:  brackish

      ABSTRACT:  The Campbell River estuary produces iron ore,
copper, lead, and zinc. Upper Cretaceous sediments and volcanic
rocks are found, as well as Pleistocene and Recent surficial
sediments; soil cover is generally sparse. Climate is mainly
maritime west coast. Freshwater inflow is provided by several
rivers, and flows are regulated by the John Hart Power
generating station. Tides are mixed, mainly diurnal; Discovery
Passage is vertically mixed and wave action is most severe at
its southern entrance. The Discovery Passage sport salmon
(Salmonidae) fishery is the second largest in British
Columbia. Zooplankton constitutes the greater part of freshwater
invertebrates. Some crabs and clams are harvested. Because of a
fire early in the 20th century, much of the present forest is
second growth. Eight floral communities of the intertidal zone
are identified. Aquatic flora of Discovery Passage is comprised
of algal phytoplankton and seaweeds; kelp and Iridaea are
abundant. In 1977, 88 species of birds were counted, and as many
as 25 terrestrial and marine species of mammals may be present.
The timber industry makes primary use of the estuary. The
Campbell River system provides the largest source of
hydroelectric power on Vancouver Island, and its lands and
waters are used extensively for recreational purposes. Sources
of pollution are mines, hydroelectric facilities, timber
industry, petroleum spills, sewage, and dredging, and these
industries are under monitoring programmes. Urbanization and
development have placed great stress on the natural communities
of birds, fish, invertebrates, and flora.

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BANK =     35              - CL SYSTEMS LIMITED -         D=  83503  ASF

TITLE:              Arsenic in U.K. estuarine sediments and its
                    availability to benthic organisms.
AUTHOR/AFFIL:       Langston,W.J. (Mar. Biol. Assoc., The Lab.,
                    Citadel Hill, Plymouth, UK)
PUBLICATION:        J. Mar. Biol. Assoc. U.K.,
                    60(4), 869-881
                    (1980)
                    JOURNAL ARTICLE - ORIGINAL RESEARCH
LANGUAGE: En;en.
ASFA  1, 11(5), MAY 81': SUBJECT SECTION 504     ABSTRACT NO.
                    07658
KEYWORDS:           arsenic, bioaccumulation, benthos,
                    brackishwater environment, sediment pollution,
                    estuaries, Bivalvia, Scrobicularia plana, ANE,
                    British Isles
AQUATIC ENVIRONMENT:  marine brackish
        ABSTRACT:   Arsenic concentrations in estuarine sediments
from England and Wales range over three orders of magnitude. The
highest concentrations, up to 2500  MU g g, occur in the
sediments of estuaries in south west England associated with

 past or present metalliferous mining activity. Strong
 correlations exist between arsenic and iron in I N-HCl extracts
 of different estuarine sediments. The As Fe ratio in those
 estuaries not contaminated with mine wastes is 11 x 10 sup - sup
 8, increasing to 190 x 10 sup - sup 4 in metalliferous
 sediments. The highest arsenic concentrations in organisms,
 almost 200  MU g g, are found at those sites in estuaries where
 high As Fe ratios exist in the sediment. Concentrations of
 arsenic in estuarine organisms correlate more significantly with
 the As Fe ratio in sediments than arsenic levels alone. This is
 most evident in Scrobicularia plana where the proportion of
 readily extractable (I N-HCl) Fe in sediments mediates the
 availability of As in a predictable way. Other factors,
 important in the selection of Scrobicularia as an indicator of
 available arsenic in sediments, such as tissue distribution and
 the effect of size age on arsenic content, are discussed.

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RANK = 36 - CI SYSTEMS LIMITED - D= 68262 ASF

TITLE: Evidence of an exhalative origin for deposits
of the Cobar district, New South Wales.
AUTHOR/AFFIL: Sangster,D.F. (Geol. Surv. Canada, 601 Booth
St., Ottawa K1A 0E8, Canada)
PUBLICATION: Bur. Miner. Resour. J. Aust. Geol. Geophys.,
4(1), 15-24
(1979)
JOURNAL ARTICLE - ORIGINAL RESEARCH
LANGUAGE: En;en.
ASFA 2, 10(10), OCT 80; SUBJECT SECTION 265 ABSTRACT NO.
07953
KEYWORDS: mineral deposits, sulphides, turbidites,
geological history, ores, Australia, New South
Wales, Cobar

ABSTRACT: Evidence is presented to show that a strong mineralogical chemical zoning exists in seven deposits of the Cobar-Nymagee area. Characteristically, the within-deposit zoning, perpendicular to bedding, consists of a siliceous chalcopyrite-pyrrhotite eastern side with diffuse contacts against adjacent siltstone-shale host rocks, and a relatively massive sulphide, banded, pyrite-sphalerite-galena western side with sharp contacts against host rocks. Features such as these are typical of those in exhalative deposits in volcanic terrain and are taken here to indicate a similar origin in this essentially non-volcanic environment. The deposits are contained indistal turbidite facies of the Devonian Cobar Supergroup, deposited in a meridional trough bounded on its eastern flank by a possible, penecontemporaneous growth fault seperating the trough from an adjacent shelf area on which were deposited shallow-water marine sediments and terrestrial and marine volcanics. This volcanism and the Cobar sedimentary-exhalative deposits may be related through rifting in the area which produced the proposed growth faults and the subsequent Cobar Trough. The deposits, now in 20 degrees discordancy to bedding, are considered to have been transposed into the prominent regional cleavage during post-ore deformation. Using the syn-sedimentary exhalative concept, two mineralised horizons and a possible tight syncline may be recognised in the CSA mine.

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RANK = 37 - CI SYSTEMS LIMITED - D= 65143 ASF

TITLE: Complexing of silica by iron(III) in natural
waters.
AUTHOR/AFFIL: Reardon,E.J. (Dep. Earth Sci., Univ. Waterloo,
Waterloo, Ont., Canada)
PUBLICATION: Chem. Geol.,
25(4), 339-345
(1979)
JOURNAL ARTICLE - ORIGINAL RESEARCH
LANGUAGE: En;en.
ASFA 2, 80(09), SEP 80; SUBJECT SECTION 184 ABSTRACT NO.
06614
KEYWORDS: silicates, solubility, iron silicates,
sulphides, silica, dissociation constants

ABSTRACT: Determination of amorphous silica solubility in acidified ferric nitrate solutions confirms the presence of ferric silicate complexing. A dissociation constant for the reaction: FeH sub 3SiO sub 4 sup 2 sup + Fe sup 3 sup ++H sub 3SiO sub 4 of 10 sup - sup 9 sup . sup 8 plus or minus 0.3 pK units at room temperature (22 plus or minus 3 C) is obtained, in close agreement with reported values at 25 C corrected to zero ionic strength of 10 sup - sup 9 sup . sup 9 by Weber and Stumm and 10 sup - sup 9 sup . sup 5 by Olson and O'Melia. Iron-silicate complexing may be of significance to the mobilization of silica in acid waters associated with oxidizing sulphide deposits and coal strip mining and the precipitation of secondary silicate mineral phases.

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BANK = 38 - CL SYSTEMS LIMITED - D= 60504 ASF

TITLE: Geochemical exploration for tin placers in St. Ives Bay, Cornwall.

AUTHOR/AFFIL: Yim,W.W.-S. (Dep. Geogr. Geol., Univ. Hong Kong, Hong Kong)

PUBLICATION: Mar. Min.,

2(1-2), 59-78
(1979)
JOURNAL ARTICLE - ORIGINAL RESEARCH

LANGUAGE: En;en.
ASFA 2, 80(07), JUL 80; SUBJECT SECTION 404 ABSTRACT NO. 05286

KEYWORDS: mineral exploration, placer mining, placers, ANE, British Isles, Cornwall, St.Ives Bay, geochemistry, dispersion, tin, alluvial deposits, mineral industry, industrial wastes

AQUATIC ENVIRONMENT: marine

ABSTRACT: After the 1961-1965 offshore tin exploration program by Coastal Prospecting Limited had been completed in St. Ives Bay, the area was re-examined to provide understanding on tin dispersion. Marine and beach sediments were studied by geochemical and sedimentological techniques. High concentrations of tin are not restricted to the mouth of the Red River only, but are found also off the Hayle Estuary and the middle portion of the bay. In the two former cases, the tin enrichment is attributed to the influence of alevial sediments containing mine tailings. In the latter case, the tin enrichment occurs in an area immediately beyond the surf zone, where a decrease in energy level causes selective concentration of tin. Beach sediments are found to change drastically during periods of beach aggradation and degradation. However, tin is found to occur in association with copper, zinc, iron, manganese, and arsenic. The presence of these elements are also thought to be due to mine tailings brought down by the Red River. Geochemical exploration permits the rapid identification of areas with high potential at low cost in prospecting for surficial marine tin placers off Cornwall. The average tin grade found in the -2057 um surficial sediment of St. Ives Bay is around 0.1% tin oxide.

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RANK = 39 - QL SYSTEMS LIMITED - D= 59958 ASF

TITLE: Complexing of silica by iron(III) in natural waters.
AUTHOR/AFFIL: Reardon, E.J. (Dep. Earth Sci., Univ. Waterloo, Waterloo, Ont., Canada)
PUBLICATION: Chem. Geol.,
25(4), 339-345
(1979)
JOURNAL ARTICLE - ORIGINAL RESEARCH
LANGUAGE: En;en.
ASFA 2, 80(C7), JUL 80: SUBJECT SECTION 184 ABSTRACT NO.
04687
KEYWORDS: silicates, solubility, iron silicates, sulphides, silica, dissociation constants

ABSTRACT: Determination of amorphous silica solubility in acidified ferric nitrate solutions confirms the presence of ferric silicate complexing. A dissociation constant for the reaction: FeH sub 3SiO sub 4 sup 2 sup + = Fe sup 3 sup + + H sub 3SiO sub 4 sup - of 10 sup 9. sup 8 plus or minus 0.3 pK units at room temperature (22 plus or minus 3 C) is obtained, in close agreement with reported values at 25 C corrected to zero ionic strength of 10 sup 9. sup 9 by Weber and Stumm and 10 sup - sup 5. sup 5 by Olson and O'Melia. Iron-silicate complexing may be of significance to the mobilization of silica in acid waters associated with oxidizing sulphide deposits and coal strip mining and the precipitation of secondary silicate mineral phases.

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RANK = 40 - QL SYSTEMS LIMITED - D= 1147 ASF

TITLE: sup 8 sup 7Sr enrichment of ophiolitic sulphide deposits in Cyprus confirms ore formation by circulating seawater.
AUTHOR/AFFIL: Chapman, H.J.; Spooner, E.T.C. (Dep. Geol. Mineral., Univ. Oxford, Oxford OX1 3PR, UK)
PUBLICATION: Earth. Planet. Sci. Lett.,
35(1), 71-78
(1977)
LANGUAGE: En;en.
ASFA 2, 78(G1), JAN 78: SUBJECT SECTION 187 ABSTRACT NO.
00215
KEYWORDS: strontium, sea water, water circulation, Cyprus, geochemistry
AQUATIC ENVIRONMENT: marine

ABSTRACT: The hypothesis that seawater was the source of the hydrothermal fluid which formed the Upper Cretaceous ophiolitic cupriferous pyrite ore deposits of the Troodos Massif (Cyprus) has been tested by analysing the strontium isotopic composition of 13 mineralized samples from 4 mines. Initial sup 8 sup 7Sr sup 8 sup 6Sr ratios range from 0.7052 plus or minus 0.0001 to 0.7075 plus or minus 0.0002, the latter value being indistinguishable from that of Upper Cretaceous seawater at 0.7076 plus or minus 0.0006 (2 SIGMA). Hence, the mineralized metabasalt samples have been contaminated with sup 8 sup 7Sr, relative to initial magmatic strontium isotope ratios of the Troodos ophiolitic complex (0.70338 plus or minus 0.00010 to 0.70365 plus or minus 0.00005). Since seawater was the only source of strontium available during formation of the Troodos Complex which was isotopically relatively enriched in sup 8 sup 7Sr, the data confirm that seawater was the source of the hydrothermal ore-forming fluid.

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BANK =     41           - QL SYSTEMS LIMITED -        D= 55710  ASF
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TITLE:                Contamination of Solvay Firth sediments by
                      coal-mining and blast furnace wastes.
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AUTHOR/AFFIL:         Perkins,E.J.; Kendrick,M. (Strathclyde Univ.,
                      Biol. Dep., Mar. Lab., The Port, Kilcreggan,
                      Dunbartonshire, G84 0JG, UK)
-----------------------------------------------------------------------
PUBLICATION:          Publ.by: Cumbria Sea-Fish. Committee; Carlisle
                      (UK).
                      Dec 1978.
-----------------------------------------------------------------------
                      90 p.
                      Sci. Rep. Cumbria Sea Fish. Comm.
                      (no.78_3)
-----------------------------------------------------------------------
                      REPORT (MONOGRAPHIC)
LANGUAGE: En;en.
ASFA  1, 80(C5), MAY 80: SUBJECT SECTION 503     ABSTRACT NO.
-----------------------------------------------------------------------
                      06204
KEYWORDS:             industrial wastes, ocean dumping, pollution
                      effects, ANE, Solway Firth, coal, mining,
                      longshore transport, trace metals, sediment
                      pollution
AQUATIC ENVIRONMENT:  marine
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        ABSTRACT:  Industrial waste solids arising from the
production of iron and coal are inroduced into the sea along 18
miles of Cumbrian coast-line between Barrowmouth, near St. Bees
Head and Maryport. Such materials are transported far up the
Solay Firth and have been recovered at Westfield some 24 miles
north-east of the nearest source. Near to the sites of input
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there may be marked ecological effects due to the scouring
action of longshore drift. At more distant sites, these
materials markedly influence the mechanical properties of the
sediments and the concentrations of the trace metals Cu, Fe, Mn,
Pb and Zn in these sediments is related to the concentration of
the fine industrial solid particles.
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BANK = 42 - QL SYSTEMS LIMITED - D= 116053 ASF

TITLE: Cellular Bioassay of Fish as a Sensitive Index
of Water Quality Related to Mine Water.
AUTHOR: Hinton, D.E.;Walker, E.R.
AFFILIATION: West Virginia University, Morgantown (USA).
Water Research Institute
PUBLICATION: Publ. by: WVU; MORGANTOWN, VA (USA)
1980.
139 pp
REPORT
LANGUAGE: En;en.
ASFA 1, 12(C9), 1982 ABSTRACT NO 11448
SUBJECT SECTION: (1)504

KEYWORDS: water quality; bioassays; freshwater fish;
pollution effects;
acid mine water
AQUATIC ENVIRONMENT: FRESHWATER

ABSTRACT: The overall objective was to develop a cellular bioassay useful in determining the effects of constituents of mine water (acid, pH, and metals) upon tissues and enzymes of freshwater fishes and to determine, via biological criteria, water quality. Coal-associated polynuclear aromatics caused induction of drug metabolizing enzymes in fish. Mn (++) caused enhanced metabolism of benzo (a) pyrene in-vitro but was inhibitory under in-vivo conditions in rainbow trout. Particulate iron (Fe 203) suspended in aquarium water and Mn (++) caused gill alterations. Most subtle changes involved swelling of surface epithelial cells (both metals) and appearance of phagocytic cells in secondary lamellae (Fe 203). Mn (++) caused a reduction in the surface microridge pattern of gill epithelia. A quantitative morphometric evaluation of control and acid-stressed (pH 4.0 or 5.0 by addition of H2SO4 to aquarium water) bullhead catfish showed a two-fold increase in the number of skin mucous cells of exposed fish, which was associated with an equivalent increase in volume density of skin mucosubstances.

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BANK =      43            - QL SYSTEMS LIMITED  -         D=  64144  ASF

TITLE:                Effects of limestone strip mining on benthic
                      macroinvertebrate communities.
AUTHOR/AFFIL:         Osborne,L.L.; Davies,R.W.; Linton,K.J. (Dep.
                      Biol., Univ. Calgary, Calgary, Alberta T2N
                      1N4, Canada)
PUBLICATION:          Water Res.,
                      13(12), 1285-1290
                      (1979)
                      JOURNAL ARTICLE - ORIGINAL RESEARCH
LANGUAGE: En;en.
ASFA  1, 80(09), SEP 80: SUBJECT SECTION 462     ABSTRACT NO.
                      12290
KEYWORDS:             benthos, water quality, USA, Pennsylvania,
                      species diversity, mineral industry, mining,
                      pollution effects, rivers, USA, Pennsylvania,
                      limestone
AQUATIC ENVIRONMENT:  freshwater
      ABSTRACT:  The changes in water quality and benthic
macroinvertetrate community structure and composition related to
limestone strip mining in western Pennsylvania are recorded and
strip mining. In contrast to coal strip mining characterized by
high total acidity and iron concentrations with decreased total
alkalinity and pH, limestone strip mining showed only a slight
increase in total acidity and bicarbonate alkalinity, and no

increase in iron concentration due to the formation of heavy
deposits of ferric hydroxide. The sulphate concentration and
conductance increased with both coal and limestone strip mining.
Limestone strip mining did not result in the extreme
deterioration of benthic community structure and composition
reported with coal strip mining. The decreased species diversity
recorded was directly correlated with the sulphate
concentrations and resulted from changes in species abundance
rather than species composition. The changes in species
abundance appear to be related to changes in food resource
availability due to the deposition of ferric hydroxide in the
detritus.

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BANK =     44              - QL SYSTEMS LIMITED  -        D=  60599  ASF

TITLE:               Environmental effects of oil shale mining and
                     processing. Part 1 , the water quality of
                     Piceance Creek, Colorado, prior to oil shale
                     processing.
AUTHOR:              Skogerboe,R.K.; Lavallee,C.S.; Miller,M.M.;
                     Dick,D.L. (Colorado State Univ., Dep. Chem.,
                     Fort Collins, CO 80523, USA)
AFFILIATION:         Environmental Protection Agency, Duluth, MN
                     (USA). Office of Research and Development.
PUBLICATION:         Publ. by: EPA; Duluth, MN (USA).
                     May 1979.
                     69 p.
                     EPA-600 3-79-055.
                     Ecol. Res. Series U.S. Environ. Protect.
                     Agency
                     REPORT (MONOGRAPHIC)
LANGUAGE: En;en.
ASFA  1, 80(08), AUG 80: SUBJECT SECTION 145      ABSTRACT NO.
                     09511
KEYWORDS:            USA, Colorado, Piceance Creek, water quality,
                     baseline studies, metals, environmental
                     effects, mining, mineral processing, oil
                     shales
AQUATIC ENVIRONMENT:  freshwater
        ABSTRACT:  Water quality data were collected at seven
sites along Piceance Creek and at one site each along Stewart,
Black Sulphur, and Yellow Creeks in the Piceance Basin,
Colorado, during 1975-77. Piceance, Stewart, and Yellow Creeks
may be perturbed by oil shale industry activities on the two
tracts, C-a and C-b, currently under development. The
preoperational water quality is generally poor due to higher
levels of dissolved solids, manganese, and both dissolved and
suspended iron. It further declined farther downstream primarily
due to influxes from groundwater aquifers in contact with
soluble mineral beds. The levels of aluminium, cadmium,

chromium, lead, and boron were below the detection limits of the
analysis method used. These were typically below the permissible
levels set for aquatic life by factors of 5-10. The levels of
copper, zinc, arsenic, selenium, and mercury were usually
measurable but still below permissible. Equilibrium calculations
indicate that the natural conditions along Piceance Creek _ in
particular the alkaline pH range (7.5-8.5) and high carbonate
alkalinity (300-800 mg CaCO3 liter) _ should limit the
solubilities of most metals to levels below the standards for
aquatic life.

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RANK = 45 - CI SYSTEMS LIMITED - Dn 6070 ASP

TITLE: An ecological survey of the heavy metal contamination of the edible clam Paphiasp. on the iron-ore tailings of Tolo Harbour, Hong Kong.

AUTHOR/AFFIL: Wong, M.-H.; Li, M.-W. (Dep. Biol., Chinese Univ. Hong Kong, Shatin, Hong Kong)

PUBLICATION: Hydrobiologia,
56(3), 265-272
(1977)

LANGUAGE: Engl.

ASFA 1, 78(04), APR 78: SUBJECT SECTION 504 ABSTRACT NO. 04575

KEYWORDS: heavy metals, bioaccumulation, Paphia, ISEW, Hong Kong, Tolo Harbour, sediment analysis, water analysis, pollution levels

AQUATIC ENVIRONMENT: marine

ABSTRACT: Iron-ore tailings have been deposited along the coast of Tolo Harbour from Ma On Shan Iron-ore Mine since its operation in 1906. In order to search for any harmful effects caused by the tailings, the edible clam, Paphia sp. together with sediments and seawater samples were collected from different sites of the iron-ore tailings of Ma On Shan Iron Mine, its nearby seashores and an unaffected site, Cheung Chau. The analysis of metal contents in the tissue and shell of the clam, seawater and sediments was carried out. It was discovered that the clams collected from the tailings had accumulated higher metal contents, e.g. Mn, Fe and Cu while those collected from the nearby seashores were also affected to a less extent. Clams are collected from the seashores within Tolo harbour for consumption by the villagers, but no accident caused by toxic effects of heavy metals has been reported. However, the present investigation further confirmed the potential hazard of the heavy metal contamination within Tolo Harbour reported recently (Wong and Chan, 1976; Wong and Tam, 1977).

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BANK =      46              - CL SYSTEMS LIMITED -          D= 123326  ASF

TITLE:                  A technique for determining low concentrations
                        of total carbonate in geologic materials.
AUTHOR/AFFIL:           Barker, J.F.;Chatten, S. (Dep. Earth Sci.,
                        Univ. Waterloo, Ont. N2L 3G1, Canada)
PUBLICATION:            CHEM. GEOL.
                        vol. 36, no. 3-4, pp. 317-323
                        (1982).
                        JOURNAL ARTICLE
LANGUAGE: En;en.
ASFA  2, 13(01), 1983  ABSTRACT NO 00160
SUBJECT SECTION:        (2)187
KEYWORDS:               carbonate minerals; soil; gas chromatography;
                        dissolution; acid rain
AQUATIC ENVIRONMENT:  FRESHWATER
         ABSTRACT:  Even small quantities of carbonate minerals
can impart a significant acid-neutralizing capacity to soils
impacted by acid waters (rain, leachate from pyritic mine
tailings, etc.). A simple analytical technique is presented for
determining the carbonate content of geologic materials
containing less than 1% carbonate minerals. Samples are
acidified and the evolved CO sub(2) measured accurately, using a
modified headspace gas-chromatographic technique. Less than
0.001 wt.% calcite can be accurately detected in geologic
samples. Six replicate analyses of a synthetic sample containing
0.075 wt.% calcite produced a mean calcite content of 0.079 wt.%
with a standard deviation of 4.7% of the mean. A major problem
in carbonate determinations where waters high in Fe super(2+)
are encountered, is the loss of carbonates resulting from acid
production viz Fe super(2+) oxidation during sample collection
and handling.

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BANK =      47              - CL SYSTEMS LIMITED -          D= 104797  ASF

TITLE:                  Investigation of Trachelomonas -Species From
                        the Mining Depression Hallerey in Dortmund-
                        Dorstfeld. - Scanning Electron Microscopy
                        and X-Ray-Analysis.
ORIGINAL TITLE:         Rasterelektronenmikroskopische und Roentgen-
                        Mikroanalytische Untersuchungen an
                        Trachelomonas  spec. des Bergsenkungsgebietes
                        Hallerey in Dortmund-Dorstfeld
AUTHOR/AFFIL:           Noll, H.;Zierold, K. (Univ. Dortmund, Abt.
                        12(Biol.), Emil-Figge-St., FRG)
PUBLICATION:            ARCH. HYDROBIOL.
                        vol. 91, no. 2, pp. 242-253
                        (1981).
                        ISSN: 0003-9136

                        JOURNAL ARTICLE
LANGUAGE: En;de,en.
ASFA  1, 12(03), 1982  ABSTRACT NO 03797
SUBJECT SECTION:  (1)504, (1)223
KEYWORDS:               ultrastructure; iron; manganese; pollution
                        indicators; shells; heavy metals; mining;
                        pollution effects;
                        Trachelomonas;
                        Germany, Fed. Rep., Westfalia, Hallerey
AQUATIC ENVIRONMENT:  FRESHWATER
         ABSTRACT:  Shells of Trachelomonadales, which were found
in the water of a mining depression during a period of 3 months
have been examined by SEM concerning their structure and by x-
ray analysis radioscopy concerning their composition of heavy
metals. The results have been brought in relation to the
chemical composition of the water. A concentration of iron and
manganese in the given species as a result of environmental
influences has been proved.
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BANK =     48              - CL SYSTEMS LIMITED -        D= 101162  ASF

TITLE:                 Ecological Effects of Mine Effluents on the
                       South Esk River, North-eastern Tasmania. II.
                       Trace Metals.
AUTHOR/AFFIL:          Norris, R.H.;Swain, R.;Lake, P.S. (Canberra
                       Coll. Advanced Educ., P.O. Box 1, Belconnen,
                       A.C.T. 2616, Australia)
PUBLICATION:           AUST. J. MAR. FRESHWATER RES.
                       vol. 32, no. 2, pp. 165-173
                       (1981).
                       JOURNAL ARTICLE
LANGUAGE: En;en.
ASFA  1, 12(02), 1982  ABSTRACT NO 02365
SUBJECT SECTION:  (1)503, (2)445
KEYWORDS:              sediment pollution; water pollution; trace
                       metals; manganese; iron; cadmium; zinc;
                       copper; lead;
                       Tasmania, South Esk R.
AQUATIC ENVIRONMENT:  FRESHWATER
       ABSTRACT:  Concentrations of manganese, iron, cadmium,
zinc, copper and lead in sediments and in the water column of
the South Esk River, Tasmania, were measured. Manganese and iron
concentrations were shown to be independent of the mine
effluents. The natural background levels of cadmium, zinc,
copper and lead were found to be very low or below detection
limits. In the stretch of river up to 130 km below a source of
contamination, the concentrations of these four metals in the
sediments, associated with the non-filterable residue, and in
solution were all well above the natural background levels.
Sediment type appears to be important in controlling

concentrations of these heavy metals. The concentrations of
cadmium and zinc in solution were inversely related to the
distance from the source of contamination, whereas the
concentrations of copper and lead in solution and of all four
metals associated with the non-filterable residue did not vary
significantly.

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BANK =     49              - CL SYSTEMS LIMITED -        D=  94798  ASF

TITLE:                 The fate of sewage phosphorus input to a
                       subarctic lake chain.
AUTHOR/AFFIL:          Drake,J.J.; Freund,I.J. (Dep. Geogr., McMaster
                       Univ., Hamilton, Ont. L8S 4K1, Canada)
PUBLICATION:           Water Air Soil Pollut.,
                       (14), 331-337
                       (1980)
                       JOURNAL ARTICLE - ORIGINAL RESEARCH
LANGUAGE: En;en.
ASFA  2, 11(9), SEP 81': SUBJECT SECTION 445     ABSTRACT NO.
                       08557
KEYWORDS:              phosphorus compounds, freshwater pollution,
                       fate, Canada, Quebec, Schefferville, nutrient
                       cycles, eutrophication, sediment pollution,
                       sedimentation
AQUATIC ENVIRONMENT:  freshwater
       ABSTRACT:  The subarctic iron-mining town of
Schefferville, Quebec discharges some 6.6 t P annually from
sewage into a lake chain. P concentrations in the receiving lake
build up during the winter, ice-cover period and the lake waters
become anoxic. Spring flushing is rapid and pronounced, and
throughout the summer lake P concentrations remain relatively
low. Iron-rich groundwater inflow to the lake promotes
sedimentation of P as Fe-phosphates in the spring when lake
waters are re-oxygenated. Sedimentation in the receiving lake
accounts for 80% of the annual sewage P load, and only 12% passes
out of the 3-lake chain studied.
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BANK =      50             - QL SYSTEMS LIMITED -         D=  91587  ASF

TITLE:             (Problems for fisheries from sand and gravel
                   exploitation).
ORIGINAL TITLE:    Probleme fuer die Fischerei bei der Sand- und
                   Kiesgewinnung.
AUTHOR/AFFIL:      Tiews,K. (Bundesforschungsanst. Fisch., Inst.

                   Kuesten- Binnenfisch., Hamburg,, GFR)
PUBLICATION:       In: (Problems of coexistence of fishery and
                   other branches of industry in exploitation of
                   the North Sea German continental shelf).
                   Probleme der Koexistenz von Fischerei und
                   anderen Wirtschaftszweigen bei der Nutzung des
                   Deutschen Festlandsockels der Nordsee.
                   Tiews,K.; Mann,H. (eds.)
                   1979.
                   p. 71-81.
                   Arb. Dtsch. Fisch.-Verb.,
                   (no. 27)
                   BOOK - CHAPTER ARTICLE
LANGUAGE: En.
ASFA  1, 11(8), AUG 81': SUBJECT SECTION 521      ABSTRACT NO.
                   12961
KEYWORDS:          gravel, underwater exploitation, mortality
                   causes, fish eggs, bottom trawls, ocean floor,
                   marine fisheries, environmental legislation,
                   enviromental impact, fishing grounds,
                   aggregates, mining, hydrogen sulphide
AQUATIC ENVIRONMENT:  marine
        ABSTRACT:  Marine sand and gravel exploitation may have
severe consequences for the fisheries; the destruction of
spawning grounds and benthic organisms, H sub 2S-containing
sediments, muddied water affecting respiration, and alteration of
sediment surface topography, affecting bottom trawling. The
possible effects are so far-reaching that mining permission must
be very carefully controlled so as not to affect the fisheries.


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RANK = 51 - CL SYSTEMS LIMITED - D= 60341 ASF

TITLE: Genesis of Upper Proterozoic stratabound copper mineralization, Kapunda, South Australia.

AUTHOR/AFFIL: Lambert, I.B.; Donnelly, T.H.; Rowlands, N.J. (Geobiol. Lab., Canberra City, Australia)

PUBLICATION: Mineral. Deposita,
15(1), 1-18
(1980)
JOURNAL ARTICLE - ORIGINAL RESEARCH

LANGUAGE: En;en.
ASFA 2, 10(10), OCT 80: SUBJECT SECTION 272 ABSTRACT NO. 08034

KEYWORDS: mineral deposits, copper, ores, sulphides, sabkhas, isotopes, geological history, Australia, South Australia, Kapunda, Proterozoic era

ABSTRACT: Chalcopyrite-rich bedded and vein mineralization at Kapunda occurs in two locally developed dolosiltstone units within a sequence of generally darker-coloured, finer-grained calcmudstones and siltstones. The Mine Series accumulated in shallow water to supratidal, sabkha-like environments; there is no evidence for igneous activity in the region. Isotope data for bedded sulphides are characteristic of biological sulphate reduction in a restricted basin. It is likely that iron sulphides were produced initially, and that copper was introduced subsequently in mildly oxidizing, highly saline groundwaters, the influence of which is seen in the sup 1 sup 3C- sup 1 sup 8O correlation for dolomite in the mineralized siltstones. Isotopic data support derivation of the veins from their host sediments, and this appears to have occurred before lithification.

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BANK = 52 - CL SYSTEMS LIMITED - D= 65586 ASF

TITLE: Metalliferous sediments in the Red Sea.
occurence, exploration and resource
assessment.
ORIGINAL TITLE: Sediments metallifers de la mer Rouge,
exploration et evaluation des reserves.
ADDENDA: (Presented at: International Seminar Offshore
Mineral Resources; Orleans (France); 23 Oct
1978).
AUTHOR/AFFIL: Baeker,H. (Dep. Explor. Mar., Preussag,
Postfach 4829, Arndtstrasse 1, 3000 Hannover
1, GFR)
PUBLICATION: In: Offshore mineral resources. Proceedings.
Ressources minerales sous-marines. Comptes-
rendus.
Bureau de Recherches Geologiques et Minieres,
Orleans (France); Groupe d'Etude et de
Recherche de Mineralisations au Large.
Publ. by: BRGM; Orleans (France).
1979.
p. 319-338
Doc. BRGM,
(no. 7)
BOOK - CHAPTER ARTICLE
LANGUAGE: En;en,fr.
ASFA 2, 80(09). SEE 80: SUBJECT SECTION 404 ABSTRACT NO.
07116
KEYWORDS: metalliferous sediments, mineral exploration,
mining, resource management, ISW, Red Sea,
iron, manganese, seafloor spreading, ores,
metals, zinc, copper, silver, environmental
impact
AQUATIC ENVIRONMENT: marine

ABSTRACT: Metalliferous sediments are formed in the central Red Sea during active sea floor spreading by interaction of heated sea water with the underlying rocks in structurally favourable positions. Iron and manganese are the predominant metals dissolved in the ore fluids. Accumulation of the valuable metals, zinc, copper and silver, to economically interesting grades requires a differentiation during precipitation. Following first scientific discoveries and research in the early sixties, systematic exploration began in 1969. Most of the Red Sea-graben has been surveyed since then. Further development work focused on the Atlantis II Deep, a 60 km sup 2 deposit containing about 2.5 million tons of zinc, also copper and silver. Pilot studies are underway now to study the feasibility of mining the mud in 2000 m water depth and to extract the metals economically. The low grade of the original wet mud requires pre-concentration on board the mining vessel, which thus leads to the necessity of a high sea disposal of the unuseful components. This again requires a thorough environmental impact study which is included in the current operations.

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RANK =      53             - QL SYSTEMS LIMITED -        D=  32972  ASF

TITLE:                Wastes from extraction and refining of ores.
ADDENDA:              (Presented at: 5. FAO SIDA Workshop on Aquatic
                      Pollution in Relation to Protection of Living
                      Resources; Manila (Philippines); 17 Jan 1977).
AUTHOR/AFFIL:         Landner,L. (Swedish Water and Air Pollut. Res.
                      Lab., Stockholm, Sweden)
PUBLICATION:          In: Lectures presented at the Fifth FAO SIDA
                      Workshop on Aquatic Pollution in Relation to
                      Protection of Living Resources. Scientific and
                      administrative basis for management measures.
                      Manila, Philippines, 17 January-27 February
                      1977.
                      FAO, Rome (Italy);
                      Swedish International Development Authority,
                      Stockholm
                      Publ.by:
                      FAO; Rome (Italy).
                      1978.
                      p. 192-204
                      BOOK - CONFERENCE PROCEEDINGS - COMPLETE
LANGUAGE: En.
ASFA  1, 79(05), MAY 79: SUBJECT SECTION 505      ABSTRACT NO.
                      07482
KEYWORDS:             pollution control, industrial wastes, mineral
                      industry, chemical pollutants, Southeast Asia
AQUATIC ENVIRONMENT:  freshwater
       ABSTRACT:  This paper describes wastes from pure mining
and dressing operations, wastes from different departments of
iron and steel works and from the non-ferrous metals industry.

The possible ways of reducing the amounts of wastes from these
different types of industries are reviewed.

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RANK =      54             - QL SYSTEMS LIMITED -        D=  64411  ASF

TITLE:                Copper and zinc in sediments of Georgia
                      Strait, B.C. in the vicinity of Texada mine.
AUTHOR:               Thompson,J.A.J.; Paton,D.W.; Timmons,M.
AFFILIATION:          Institute of Ocean Sciences, Patricia Bay,
                      Sidney, BC (Canada).
PUBLICATION:          Publ. by: IOS; Sidney, BC (Canada).
                      1979.
                      17 p.
                      Pac. Mar. Sci. Rep. (IOS).
                      (no. 79-17)
                      REPORT (MONOGRAPHIC)
LANGUAGE: En;en.
ASFA  1, 80(09), SEP 80: SUBJECT SECTION 503      ABSTRACT NO.
                      12557
KEYWORDS:             copper, zinc, sediment analysis, chemical
                      pollutants, industrial wastes, quantitative
                      distribution, INE, Georgia Strait, sediment
                      pollution, mineral industry
AQUATIC ENVIRONMENT:  marine
       ABSTRACT:  The copper and zinc concentrations in
sediments of Georgia Strait, B.C., adjacent to the inactive
iron-copper mine on Texada Island, are reported. Copper
concentrations in 32 samples ranged from 16  MU g g sup - sup 1
to 1584  MU g g sup - sup 1 and exhibited a distribution pattern
relating these elevated concentrations to the mine as source. No
significant elevation of zinc in the samples (range 28-195  MU g
g sup - sup 1, dry weight) was observed although a statistically
significant relationship between copper and zinc levels was
established.
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BANK = 55 - CL SYSTEMS LIMITED - D= 101152 ASF

TITLE: Characterization of Mercury in a Riverwash Soil.

AUTHOR/AFFIL: Harsh, J.B.; Doner, H.E. (Dept. Plant Soil Biol., Univ. CA, Berkeley, CA 94720, USA)

PUBLICATION: J. ENVIRON. QUAL.
vol. 10, no. 3, pp. 333-337
(1981).

JOURNAL ARTICLE

LANGUAGE: En;en.

ASFA 1, 12(02), 1982 ABSTRACT NO 02355

SUBJECT SECTION: (1)503, (2)445

KEYWORDS: mercury; soil; environmental impact; chemical analysis; fate; river banks; mineral industry;
USA, California, James Creek

AQUATIC ENVIRONMENT: FRESHWATER

ABSTRACT: Contaminated soil was collected from the banks of James Creek, Napa County, California. The extent of cinnabar (alpha -HgS) degradation in the riverwash soil polluted by Hg mining waste was evaluated by determination of persistent alpha -HgS and Hg liberated from the mineral. The soil was sequentially extracted to determine soluble, exchangeable, manganese-oxide-associated, and free iron-oxide-associated Hg. Only traces of Hg were recovered by the chemical extractants, implying that very little existed in an adsorbed or easily soluble state. This Hg remained primarily in the alpha -HgS form. Loss of Hg in the tetrabromoethane separations and at low temperatures during the thermal fractionation suggested that Hg in both the colloidal and lighter fractions was organically bound.

BANK = 56 - CL SYSTEMS LIMITED - D= 15616 ASF

TITLE: Heavy metals in the burrowing bivalve Scrobicularia plana from contaminated and uncontaminated estuaries.

AUTHOR/AFFIL: Bryan, G.W.; Hummerstone, L.G. (Mar. Biol. Assoc., Citadel Hill, Plymouth PL1 2PB, UK)

PUBLICATION: J. Mar. Biol. Assoc. U.K.,
58(2), 401-419
(1978)

LANGUAGE: En;en.

ASFA 1, 78(09), SEP 78: SUBJECT SECTION 504 ABSTRACT NO. 10930

KEYWORDS: heavy metals, silver, cadmium, cobalt, chromium, copper, iron, manganese, nickel, lead, zinc, Scrobicularia plana, British Isles, Gannel R., ANE, British Isles, Gannel Estuary, British Isles, Camel R., ANE, British Isles, Camel Estuary

AQUATIC ENVIRONMENT: marine brackish

ABSTRACT: Concentrations of 10 metals (Ag, Cd, Co, Cr, Cu, Fe, Mn, Ni, Pb, Zn) have been analysed in the soft tissues of S. plana (da Costa) from sites in the Gannel and Camel Estuaries in South-West England. In the Gannel Estuary, which receives wastes from old lead mines, the animals contained about an order of magnitude higher concentrations of lead, cobalt, cadmium and zinc than in the Camel Estuary and higher concentrations of other metals also. Differences were also observed between the sediments. In both populations, less than 50% of the total silver, copper and iron was found in the digestive gland. For the other metals over 50% occurred in this organ and, in large Gannel animals, more than 90% of the lead, cobalt, cadmium and zinc, implying that they are chiefly absorbed from ingested sediment. In the contaminated Gannel animals, all metal concentrations, with the exception of manganese and iron, increased with increasing size. The main contrast in the Camel animals concerned the concentrations of cadmium and zinc which were independent of size. This suggests a possible relationship between the slope of the concentration size regression and the level of contamination, although differences in growth rate may also be involved. When animals were exchanged between the 2 estuaries, their metal concentrations approached those of the natives very slowly. Even after a year, concentrations of lead, cobalt, cadmium and zinc in the digestive gland were still markedly different from those of native animals. The use of Scrobicularia as an indicator of metal contamination is discussed. It is concluded that it should normally be regarded as a long-term integrator of the chronic type of contamination usually associated with estuarine sediments.

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2,051 LINES, 56 DOCUMENTS END OF PRINT REQUEST

M

APPENDIX M

CANADIAN ENVIRONMENT (CENV) DATABASE

SEARCH #1 OF 2

SEARCH STRATEGY:

[MINE(S) OR MINING]

AND

[DRAINAGE OR WATER(S) OR WASTE(S) OR WASTEWATER(S)]

AND

[PYRIT? OR SULPHIDE OR SULFIDE OR IRON]

AND

[BACTERIAL OXIDATION OR BACTERIAL LEACHING]

64691 UPDATE NO.: CENV84(1)
A simulation of the effects of bacteria, organics and salt solutions on uranium mine mill tailings from Elliot Lake, Ontario, Chapter 37
SILVER M, RITCEY GM
AFFILIATION: Process Metall Sect, Extr Metall Lab, Miner Sci Lab, Can Cent Miner Energy Technol, Energy, Mines Resour, 555 Booth St, Ottawa, Ont K1A 0G1
ED.: MOO-YOUNG M, ROBINSON CW, FARQUHAR GJ
Waste Treatment and Utilization, Theory and Practice of Waste Management 2, Proc Second Int Symp Univ Waterloo, Waterloo, Ont, June 18-20, 1980
Pergamon Press, Toronto, Ont ISBN 0 08 024012 7
1982 489-501 1 fig. 5 tab. 14 ref LANG.: En
PUBLICATION TYPE: 4 Conference paper SCI.: COPP
REF. SOURCE: 0010501 REF. SOURCE NO.: TD 896 W36 1980
GEOGRAPHIC ID.: NP2 NE,NM6 1S
KEYWORDS: Elliot Lake, Ontario, mine wastes, simulation, uranium, bacteria, organic matter, radium, lysimeters, leaching, iron, solvent extraction reagents, industrial wastes, sulfates, sulphates, hydrogen ion concentration, kerosene, brines, tertiary amines, wastewater treatment

The effect of iron-oxidizing bacteria and organic solvent extraction reagents on uranium mine mill tailings from Elliot Lake, Ontario were examined to establish a model to predict acid formation and radium-226 leaching. In a series of lysimeter tests simulating abandoned tailings, accelerated by a nine-fold exposure to sunlight and darkness, wind and the amount of precipitation normally associated with the area at 18 plus or minus C, the elution of radium-226, thorium, uranium, sulfate, total iron and the pH were monitored. The tests were conducted in the presence of bacteria either in the absence or presence of a mixture of kerosene, a tertiary amine and isodecanol applied to about one tonne of fresh tailings; the bacteria in a control lysimeter box were inhibited with hypochlorite bleach. The patterns of the elution of radium-226, total iron, sulfate and uranium and the pH changes with time were similar in both lysimeter boxes containing bacteria but were different in the lysimeter box to which the bleach was applied. The proportion of radium-226 eluted in about 750 days (or 19 simulated years) was 2.3-2.4% from the lysimeter boxes in which the bacteria were active and 3.4% in which the bacteria were inhibited with bleach. The tertiary amine was completely eliminated within 91 days (or 2.3 simualted years) and the kerosene within 1 1/2 years (or 10.8 simulated years) from the lysimeter box to which these are added. In a separate experiment using tailings from the same source, about half the radium-226 was removed by treatment with salt solutions and water. Radium-226 in the effluents of columns packed with these treated tailings was decreased by about 90% compared with columns packed with untreated tailings.

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61532 UPDATE NO.: CENV81(4)
Waste water survey, Coleman Collieries Ltd., Tent Mountain Strip Mine, Coleman, Alberta, 1976
SCHONEKESS R, HAMMOND C
Alberta Environ, Pollut Control Div, Water Qual Control Branch
1977-10 37p 3 tab, 2 fig, 3 app LANG.: En
PUBLICATION TYPE: 3 Report SCI.: AEEN
REF. SOURCE: 2010101 REF. SOURCE NO.: TD897 A4 C69 A333
GEOGRAPHIC ID.: W114 30,N49 40
KEYWORDS: Ptolemy Creek, Crowsnest Creek, Coleman, Alberta, Coleman Collieries Limited, Tent Mountain Strip Mine, surveys, industrial wastewater, iron, wastewater analysis, settling basins, mine wastes, suspended solids, water quality standards, water sampling

Crowsnest Creek and Ptolemy Creek were sampled in early May 1976 and September 1976 to determine the effectiveness of the Coleman Collieries settling ponds in removing non-filtrable residue (suspended solids) and iron for the strip mining operations on Tent Mountain. A four-day survey was conducted in May. Fifteen sampling locations along East and West Crowsnest Creeks, pond inlets and outlets, and Crowsnest and Ptolemy Creeks were sampled. Ptolemy Creek was selected to provide some background data from an unmined area for comparision with the mined areas. The sites were sampled again in September to supplement the May data. The results of the surveys showed that the ponds were effective in reducing the non-filtrable residue and iron in the creeks below the ponds. Reductions in the non-filtrable residue concentrations ranged from 69% to 99% although some values were more than 10 mg/l higher than those of Ptolemy Creek. Iron concentrations were reduced to less than 1 mg/l. In terms of the Permit to Construct, the settling ponds operated by Coleman Collieries enable compliance to the 50 mg/l limitation for non-filtrable residue, pH and iron concentration limits.

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RANK =       3              - QL SYSTEMS LIMITED -        D=  54379  CEN

60090          UPDATE NO.: CENV83(1)
Measurement of sediment transport in the Schefferville mining
area, central Quebec-Labrador peninsula

MANSIKKANIEMI H
AFFILIATION: Dep Geogr, Univ Turku, SF-20500 Turku 20, FI
IN: Environmental studies in the central Quebec-Labrador
peninsula:  Finnish contributions, Nevo-Schefferville Subarctic
Exchange Program 1978-79
McGill Subarct Res Pap 30
Cent North Stud Res McGill Univ, Cent North Stud Res, 1020 Ave
des Pins, Montreal, Que H3A 1A2  PUBLISHER NO.: ISSN 0076-1982
1980-01 65-80 11 ref, 7 fig  LANG.: En
PUBLICATION TYPE: 3 Report
REF. SOURCE: 0010501
NOTES: Financial support from Can Minist Intergov Aff, Gov
Quebec; Donner Can Found, McGill Univ
GEOGRAPHIC ID.: W66 50,N54 49
KEYWORDS: Labrador, Quebec, Schefferville, sediment transport,
sedimentology, iron mines, streams, gravel, suspended solids,
suspended sediments, conductivity, mine drainage, water
pollution sources
    This report gives a general description of the intensity of
sediment transport during summer in a mining area of the central
Quebec-Labrador peninsula.  To define the problem, concentration
of suspended solids and the electrical conductivity in different
drainage streams in the mining area were measured.  One of the
streams was carrying mine drainage, and two had carried it in
the past.  Three were affected by human activity were also
studied.  This study demonstrates that the water of a creek,
such as Kyle Creek, may have a mine pit at the boundary of its
drainage area, but can still be pure and clear.  The study also
shows that coarse materials are transported only a short
distance, gravel and coarse sand being deposited within metres
of the base of dumps.  The direct effects of mining on the
drainage basins of the Schefferville area are of minor
importance, mainly because iron ore is not refined in the area
and polluting chemicals dumped into the local streams and lakes.
The water pumped from mine pits is red and muddy, but is not,
strictly speaking, polluted, as is the waste water of the mining
town.

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RANK = 4 - QL SYSTEMS LIMITED - D= 54376 CEN

60087 UPDATE NO.: CENV83(1)

Some aspects of the recovery of a stream from iron ore mining activities near Schefferville, Quebec

DCEREUII EA

AFFILIATION: Dep Geogr, McMaster Univ, Hamilton, Ont L8S 4K1

IN: Environmental studies in the central Quebec Labrador peninsula

ED.: MCCANN SB

McGill Subarct Res Pap 32

McGill Univ, Cent North Stud Res, 1020 ave des Pins, Montreal, Que H3A 1A2 ISSN 0076-1982

1981 39-55 8 ref, 6 fig, 1 tab LANG.: En

PUBLICATION TYPE: 3 Report

REF. SOURCE: C01C501

GEOGRAPHIC ID.: N66 56,N54 49

KEYWORDS: Schefferville, Quebec, Kata Creek, suspended solids, iron mines, mine wastes, conductivity, creeks, streams, sediments, wastewater, hydrogen ion concentration, environmental effects, water quality, water pollution sources

Suspended solids concentrations, pH, and electrical conductivity were measured at several points along a disturbed creek near Schefferville, Nouveau-Quebec. Kata Creek received waste water from an iron mine until late 1978. Comparison of data obtained before and after the closure of the mine suggests that the water quality has improved, with an enormous reduction in turbidity and suspended solids (from a maximum of 2120 mg. per l in 1978 to 6 mg. per l in 1979). Electrical conductivity has also decreased since 1978. Changes in underlying geology and the activity of microorganisms are reflected in pH values obtained in 1979 from both Kata Creek and an adjacent undisturbed stream. The physico-chemical characteristics of the water in Kata Creek have apparently returned to normal insofar as conductivity and suspended solids are concerned. However, the flora and fauna appear to be responding much more slowly to the improvement in water quality.

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57512 UPDATE NO.: CENV82(4)
Guidelines for the control of liquid effluents from existing metal mines, Draft No. 10
Dep Environ
Technology Transfer Seminar on Mining Effluent Regulations/Guidelines and Effluent Treatment Technology as Applied to the Base Metal, Iron Ore and Uranium Mining and Milling Industry, Seminar notes, Sudbury, Ont, November 5-6, 1975, Montreal, Que, November 17-18, 1975, Banff, Alta, December 9-10, 1975
Dep Environ
1975-10 18p 3 tab LANG.: En
PUBLICATION TYPE: A Conference paper
REF. SOURCE: 0010901 REF. SOURCE NO.: WATDOC 57504
NOTES: Seminar sponsored by Environ Prot Serv, Environ Can and The Can Inst Min Metall
KEYWORDS: industrial wastes, mine wastes, effluents, metals, surface drainage, arsenic, copper, lead, nickel, zinc, suspended solids, radium 226, hydrogen ion concentration, sampling, monitoring, toxicity, bioassay, fish, water use, liquid wastes

Guidelines are presented which apply to all existing metal mines except gold mines. These guidelines, published by Environment Canada, describe the practices that should be followed by mine operators for compliance with the general pollution provisions of the Fisheries Act. Definitions are given of terms used in the Guidelines and substances and parameters to be considered are listed. Acceptable levels of substances are shown in tabular form and guidelines for the frequency of sampling and analysis of a final effluent are given. A final evaluation test procedure (96 hour flow through bioassay test) and a screening test procedure (96 hour static test) to be carried out by mine operators are outlined. Methods of reporting are described and procedures for disposal of tailings and waste rock are listed. Guidelines relating to the minimization of fresh water requirements and final effluent volumes are given and minimization of contaminated surface drainage is discussed. Analytical test methods for determining concentrations of substances in liquid effluents are listed.

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57511 UPDATE NO.: CEAV82(4)

Technology Transfer Seminar on Mining Effluent Regulations/ Guidelines and Effluent Treatment Technology as Applied to the Base Metal, Iron Ore and Uranium Mining and Milling Industry, Seminar notes, Sudbury, Ontario, November 5-6, 1975, Montreal, P.Q., November 17-18, 1975, Banff, Alta, December 9-10, 1975

nd vp fig, tab, ref LANG.: En

PUBLICATION TYPE: 5 Proceedings

REF. SOURCE: 0010901 REF. SOURCE NO.: WATDOC 57509

NOTES: Seminar sponsored by Environ Prot Serv, Environ Can and the Can Inst Min Metall

KEYWORDS: mine wastes, wastewater management, water pollution control, mining industry, effluents, metals, acid mine drainage, sulphides, sulfides, minerals, toxicity, testing procedures, bioassay, water use, pilot plants, mills, industrial plants, planning liquid wastes

The proceedings include drafts of regulations and guidelines to be followed by mine operators on: (1) metal mining liquid effluent, (2) the control of liquid effluents from existing metal mines and (3) the measurement of acute toxicity. A draft of the Environmental Code of Practice for Mines is included and a procedure for determining the net acid generating potential of sulphide minerals and wastewater is described. A brief summary is given of the methods available for measuring low levels of metals and information is presented relating to the toxicity and the toxicity testing of effluents from the metal mining and milling industry. The data and recommendations developed by the Minimization Working Group of the National Mining Effluent Regulations Task Force following their examination of water management practices within the metals mining industry are presented. The technology involved with tailings pond and lagoon based treatment systems are discussed and the metals removal phase of a mine wastewater pilot treatment project at the Mining Division site of Brunswick Mining and Smelting Corp. Ltd is described. Some notes on the subject of integrated mine wastewater system design and selection are presented to emphasize the importance of integrated planning and design. A case study of acid drainage control and water treatment at Heath Steele Mines Ltd. in New Brunswick is included.

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57504 UPDATE NO.: CENV82(4)

Guidelines for the measurement of acute toxicity and the control of effluents from new, expanded and reopened metal mines, Draft No. 5

Dep Environ

Technology Transfer Seminar on Mining Effluent Regulations/ Guidelines and Effluent Treatment Technology as Applied to the Base Metal, Iron Ore and Uranium Mining and Milling Industry, Seminar notes, Sudbury, Ont, November 5-6, 1975, Montreal, Que, November 17-18, 1975, Banff, Alta, December 9-10, 1975

Dep Environ
1975-10 11p LANG.: En
PUBLICATION TYPE: 4 Conference paper
REF. SOURCE: 0010901 REF. SOURCE NO.: WATDOC 57504
NOTES: Seminar sponsored by Environ Prot Serv, Environ Can and the Can Inst Min Metall

KEYWORDS: toxicity, metals, mine wastes, effluents, fish, bioassay, rocks, water use, surface drainage, contamination, oil, ammonia, nutrients, sulfates, sulphates, thiosalts, liquid wastes, hydrogen ion concentration

Guidelines are presented which apply to the measurement and control of effluents from all metal mines except gold mines. These guidelines, published by Environment Canada, describe the practices that should be followed by mine operators for compliance with the general pollution provisions of the Fisheries Act. Definitions are given of terms used in the guidelines. It is stated that effluent is unacceptable if more than 50% of the fish die in the bioassay sample within 96 hours when tested according to the Final Evaluation Test Procedure (Flow Through Test) which is included with these guidelines. Guidelines are presented for tailings and waste rock disposal and for the minimization of fresh water requirements and final effluent volumes. The minimization of contaminated surface drainage is discussed and other parameters are listed which mine operators should attempt to minimize in mine effluents.

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BANK =      8             - QL SYSTEMS LIMITED -         D=  43444  CEN

49149           UPDATE NO.: CENV81(5)
The problem of acid mine drainage in the province of Ontario
HAWLEY JR
AFFILIATION: Min Metall Unit, Waste Syst Plann Sect, Waste
Manage Branch, Ont Minist Environ, 135 St Clair Ave West,
Toronto, Ont
Ont Minist Environ, Toronto, Ont
1977 338p ref, fig, tab  LANG.: En
PUBLICATION TYPE: 3 Report
REP. SOURCE: 2060201  REP. SOURCE NO.: TD899.M5H39
KEYWORDS: Ontario, acid mine water, mine drainage, hydrology,
mining, mine wastes, sulphide mining, milling, sulphosalts, iron
sulphides, solubility characteristics, chemical characteristics,
physical characteristics, structural characteristics, stability,
effluents, wastewater recycling, treatment, tailings
    This report contains thirty sections regarding various
aspects of the problem of acid mine drainage in the Province of
Ontario.  Some basic conclusions that are either stated or
implied in the report are:  acid mine drainage is common in the
sulphide mining camps of the Province of Ontario; the problem of
acid mine drainage varies in number and extent from property to
property and the solution to any particular problem depends
largely on local circumstances.  Five circumstances are noted in
this report; drainage problems occurring in the Province of
Ontario are a result of the decomposition of the iron sulphide
minerals pyrite, pyrrhotite and marcasite; drainage problems can
continue at a property long after the property has been
abandoned; Conventional mine-mill waste treatment techniques
vary greatly in effectiveness.  However, even the most effective
techniques cannot, by themselves, achieve a product that is
completely acceptable for discharge to a natural watercourse;
and three basic waste treatment oriented techniques should be
considered at every property where acid mine drainage problems
are existent or expected:  mine-mill wastewater re-use, gangue
sulphide recovery, and revegetation of abandoned or unused
areas.

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RANK =      5              - CL SYSTEMS LIMITED -        D=  37020  CEN

43522           UPDATE NO.: CENV(A)
MINE-MILL WASTEWATER TREATMENT AT BRUNSWICK MINES
PEASE DR
AFFILIATION: BRUNSWICK MINING SMELTING CORP LTD, BATHURST, NB
CANADIAN MINING JOURNAL CAMJ-A
1980-03 101 003 31, 33
PUBLICATION TYPE: 1 Article
REF. SOURCE: 0010501

KEYWORDS: MINING, BATHURST, NEW BRUNSWICK, BRUNSWICK MINES,
INDUSTRIAL WASTES, WASTE WATER TREATMENT, RECYCLING, TREATMENT
PLANTS, ACID MINE DRAINAGE, TAILINGS DECANT WATER, THIOSALTS
    BRUNSWICK MINING AND SMELTING CORPORATION LIMITED OPERATES
TWO MINES -- ONE OPEN PIT (NO. 6) AND ONE UNDERGROUND (NO. 12),
APPROXIMATELY 20 MILES SOUTHWEST OF BATHURST, NEW BRUNSWICK.
BOTH ARE MASSIVE SULPHIDE DEPOSITS CONTAINING COPPER, LEAD, ZINC
AND SILVER.  THE NO. 12 PROPERTY BEGAN OPERATION IN 1963 AND IS
PRESENTLY BEING MINED AT A RATE OF 8600 TONS PER DAY UNDERGROUND
AND IS IN THE COMPLETION STAGES OF AN EXPANSION TO ACHIEVE
11,000 TPD UNDERGROUND BY THE END OF 1980.  THE AUTHOR POINTS
OUT THE INADEQUACIES OF A CONVENTIONAL WASTE WATER TREATMENT
RECYCLE SYSTEM THAT WAS IN OPERATION AT BRUNSWICK MINING.  A
THREE-PHASE PROGRAM TO CONTROL EFFLUENTS FROM THE PROPERTY IS
REVIEWED:  PHASE 1:  SURFACE DRAINAGE CONTROL AND CONSTRUCTION
OF AN ACID MINE DRAINAGE TREATMENT PLANT; PHASE 2:
ESTABLISHMENT OF A SYSTEM TO RECYCLE TAILINGS DECANT WATER ONLY;
PHASE 3:  ESTABLISHMENT OF A METHOD AND SYSTEM TO TREAT
THIOSALTS IN THE CANADIAN CLIMATE.  1 FIG, 1 PHOTO

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RANK =     10              - CL SYSTEMS LIMITED -         D=  34180  CEN

39085           UPDATE NO.: CENV(A)
TREATMENT OF BASE METAL MINE DRAINAGE
BUCK PB, LECLAIR BP
AFFILIATION: DEPT CHEM ENG MCMASTER UNIV, HAMILTON, ONT
PROC 30TH INDUSTRIAL WASTE CONF, MAY 6-8, 1975, PURDUE
UNIVERSITY
ANN ARBOR SCIENCE PUB INC ANN ARBOR, MICH
1976 1161-1172
PUBLICATION TYPE: 5 Proceedings
REF. SOURCE: 0010501
KEYWORDS: MINING MINES, INDUSTRIAL WASTES, MINE DRAINAGE, MINE
WATER, MINING ENGINEERING, WASTE DISPOSAL, BASE METAL,
TREATMENT, DATA COLLECTION, NEW BRUNSWICK, MINEWATER
CHARACTERISTICS, EFFLUENT LEVELS, ACID MINE WATER, LIME
REQUIREMENTS, SAND FILTRATION, LEAD, ZINC, COPPER, IRON
    THIS PAPER WAS PRESENTED AT THE THIRTY-FIRST INDUSTRIAL
WASTE CONFERENCE, HELD AT PURDUE UNIVERSITY, MAY 4-6, 1976.
RESOURCE DEVELOPMENT IN NORTHEASTERN NEW BRUNSWICK IS CENTERED
ON THE FORESTS, MINERALS AND FISHERIES OF THE REGION.  THE
VALUABLE FISHERY RESOURCE HAS BEEN THREATENED BY WATER QUALITY
PROBLEMS WHICH ARE PARTLY ATTRIBUTABLE TO BASE METAL MINING
OPERATIONS. AS A RESULT, A PILOT TREATMENT PLANT WAS ESTABLISHED
AT THE BRUNSWICK MINING AND SMELTING CORPORATION'S NO. 12 MILL
TO DEVELOP AND DEMONSTRATE NEW AND EXISTING TECHNOLOGY FOR THE
REMOVAL OF HEAVY METALS FROM BASE METAL MINING EFFLUENTS.
COINCIDENT WITH THE PILOT PLANT PROGRAM, A RESEARCH PROGRAM ON
NEUTRALIZATION REAGENT ALTERNATIVES, POLYMER RAPID MIX AND
FLOCCULATION METHODS AND EFFLUENT POLISHING TECHNIQUES WAS

INITIATED AT THE WASTEWATER TECHNOLOGY CENTRE.  OVERALL PROGRAM
OBJECTIVES WERE TO DETERMINE EFFLUENT METAL LEVELS USING
CONVENTIONAL TREATMENT, TO DEFINE PERFORMANCE CHARACTERISTICS OF
THE UNITS IN THE TREATMENT PROCESS, TO INVESTIGATE SLUDGE
DENSIFICATION AND HANDLING AND TO EXAMINE EFFLUENT POLISHING
TECHNIQUES WHERE REQUIRED.  5 REF, 5 FIG, 5 TAB.
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RANK = 11 - QL SYSTEMS LIMITED - D= 26481 CEN

32011 UPDATE NO.: CENV(A)
SCAVENGING AND FLOCCULATION OF METAL-BEARING WASTEWATERS USING
POLYELECTROLYTES
HUCK PM, MURPHY KL, LECLAIR BP
AFFILIATION: MCMASTER UNIV, HAMILTON, ONT, WASTEWATER TECH
CENTRE, ENVIR PROTECTION
TECHNOLOGY DEVELOPMENT REPORT
FISHERIES AND ENVIRONMENT CANADA, EPS, OTTAWA, ONTARIO
PUBLISHER NO.: EPS-4-WP-77-7
1977-11 98 P
PUBLICATION TYPE: 3 Report
REF. SOURCE: 0010901 REF. SOURCE NO.: 32011
NATIONAL RESEARCH COUNCIL OF CANADA
KEYWORDS: WASTEWATER, FLOCCULATION, WASTEWATER TREATMENT,
POLYMERS, MINE WATER, AGGREGATION RATE, CONCENTRATION, FLOC
STRENGTH, METAL CONCENTRATION, POLYELECTROLYTES

THIS STUDY DETERMINED OPTIMUM CONDITIONS FOR THE USE OF
POLYMERS IN FLOCCULATION OF METAL HYDROXIDES PRESENT IN
NEUTRALIZED MINE DRAINAGE. USING THE CRITERION OF SUPERNATANT
PARTICULATE METAL CONCENTRATION FOLLOWING FLOCCULATION AND
SETTLING, OPTIMUM POLYMER PROPERTIES AND MIXING CONDITIONS WERE
OBTAINED FOR BOTH STRONG AND WEAK SIMULATED MINEWATERS
CONTAINING IRON. IT WAS SHOWN THAT THESE CONDITIONS ALSO
PROVIDED MINIMUM METAL RESIDUALS (LESS THAN 0.3 MG PER L) FOR
SIMULATED MINEWATERS CONTAINING COPPER OR ZINC. FOR TWO METAL
SYSTEMS, THE RESIDUAL PARTICULATE METAL CONCENTRATIONS ACHIEVED
WERE LOWER THAN FOR THE CORRESPONDING SINGLE METAL SYSTEMS.
EXPERIMENTS PERFORMED TO DETERMINE THE BEST KINETIC MODEL FOR
THE PROCESS DEMONSTRATED THAT IT COULD NOT BE REPRESENTED BY A
SIMPLE AGGREGATION MODEL, AND THAT NONE OF THE AVAILABLE MODELS
INCORPORATING FLOC BREAKUP WERE ADEQUATE. A NEW MODEL WAS
PROPOSED WHICH INCORPORATED FOR THE FIRST TIME THE DECREASE IN
THE AGGREGATION RATE WITH TIME BECAUSE OF THE SHORTENING OF THE
ADSORBED POLYMER LOOPS, AND THE EXISTENCE OF A CRITICAL MIXING
INTENSITY FOR FLOC BREAKUP. THIS MODEL, WHICH IS SECOND ORDER
IN PARTICLE CONCENTRATION, WAS FOUND TO PREDICT SATISFACTORILY
THE RESULTS OBTAINED WITH THE SIMULATED IRON, COPPER AND ZINC
MINEWATERS. ALTHOUGH THE AGGREGATION RATE WAS GREATER FOR ZINC
THAN FOR IRON OR COPPER, THE ACHIEVABLE SUPERNATANT PARTICULATE
CONCENTRATION WAS INDEPENDENT OF METAL TYPE. THE CRITICAL MIXING
INTENSITY FOR FLOC BREAKUP WAS FOUND TO INCREASE WITH INCREASING
INITIAL METAL CONCENTRATION. THE MODEL WAS TESTED ON THREE
ACTUAL MINEWATERS AND WAS FOUND TO GIVE SATISFACTORY
PREDICTIONS. 13 FIG, 25 TAB, 1 APP, 47 REF.

* * *

RANK = 12 - QL SYSTEMS LIMITED - D= 24310 CEN

29716 UPDATE NO.: CENV(A)
ENVIRONMENTAL CODE OF PRACTICE FOR MINES
METAL MINING LIQUID EFFLUENT REGULATIONS AND GUIDELINES
REGULATIONS, CODES AND PROTOCOLS
FISHERIES AND ENVIRONMENT CANADA, EPS, WATER POLLUTION CONTROL
DIR. OTTAWA, CANADA PUBLISHER NO.: EPS-1-WP-77-1
1977-04 1-27 LANG.: E, F
PUBLICATION TYPE: 3 Report
REF. SOURCE: 0010901 REF. SOURCE NO.: 29787
KEYWORDS: INDUSTRIAL LIQUID EFFLUENTS, WASTE ROCK, MILL
TAILINGS, ENVIRONMENTAL CONTROL, WATER BORNE WASTES, MILL
PROCESS EFFLUENT, WASTE TREATMENT, RADIONUCLIDES, SURFACE
DRAINAGE, MINES, THIOSALTS, PH CONTROLS, MONITORING, METALS

THIS CODE OF PRACTICE APPLIES TO INDUSTRIAL LIQUID
EFFLUENTS, AND WASTE ROCK AND MILL TAILINGS RESULTING FROM BASE
METAL, URANIUM AND IRON ORE SEGMENTS OF THE MINING AND MILLING
OPERATIONS OF THE INDUSTRY. IT IS INTENDED TO BE A GUIDE FOR
PROFESSIONALS IN MEETING THEIR ENVIRONMENTAL CONTROL
RESPONSIBILITIES AND EMPHASIZES POLLUTION CONTROL PRACTICES THAT
SHOULD BE CONSIDERED AT ALL STAGES OF MINE - MILL DEVELOPMENT,
FROM INITIAL PLANNING THROUGH TO ABANDONMENT. TOPICS INCLUDE:
MINIMIZATION AND TREATMENT OF WATER BORNE WASTES, WASTE ROCK AND
MILL TAILINGS DISPOSAL MONITORING, CONTINGENCY PLANNING AND
REHABILITATION. 3 TAB. 5 REF.

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RANK = 13 - QL SYSTEMS LIMITED - D= 12289 CEN

16114 UPDATE NO.: CENV(A)
DEVELOPMENT OF A BIOLOGICAL SYSTEM FOR THE TREATMENT OF MILL
WASTE WATERS CONTAINING THIOSULFATE--PROJECT 1525
BC RESEARCH, VANCOUVER BC
PROJECT 1525
ENVIRONMENT CANADA, WATER MANAGEMENT SERVICES OTTAWA ONTARIO
1973-06 30 P
PUBLICATION TYPE: 3 Report
REF. SOURCE: 0010104 REF. SOURCE NO.: 16114
ENVIRONMENT CANADA, INLAND WATERS DIRECTORATE, WATER QUALITY
BRANCH

KEYWORDS: BIOLOGICAL TREATMENT, WASTE WATER POLLUTION, ACID MINE
WATER, WASTE WATER TREATMENT, THIOBACILLUS FERROOXIDANS,
THIOBACILLUS THIOOXIDANS, NEW BRUNSWICK, IRON BACTERIA, SULFUR
BACTERIA, EFFLUENTS, HYDROGEN ION CONCENTRATION, BIODISE,
ENGINEERING DESIGN ACTIVATED SLUDGE

THIS REPORT DESCRIBES THE ENGINEERING DESIGN PARAMETERS NECESSARY FOR THE OPERATION OF A BIOLOGICAL SYSTEM TO TREAT A NEW BRUNSWICK FLOTATION-MILL WASTEWATERS CONTAINING THIOSULFATE. A LITERATURE SURVEY COVERS NUTRITIONAL AND ENVIRONMENTAL FACTORS INFLUENCING THE OXIDATION OF THIOSULFATE BY THIOBACILLI. LABORATORY STUDIES WERE CARRIED OUT TO ASSESS THE PRACTICALITY OF USING THIOBACILLUS SPECIES TO OXIDISE THIOSULFATE IN WASTE WATER. AS A RESULT OF THIS A SIMULATED ACTIVATED SLUDGE SYSTEM WITH RECYCLE AND A FIXED FILM REACTOR WAS SELECTED. A PILOT PLANT SYSTEM WAS DESIGNED TO OPERATE AT 10 GAL./MIN. 46 REF., 11 FIG., 7 TABLES.

* * *

RANK = 14 - QL SYSTEMS LIMITED - D= 11434 CEN

15054 UPDATE NO.: CENV(A)
CHEMICAL OXIDATION OF INDUSTRIAL WASTES
EISENHAUER HR
AFFILIATION: DEPT NATIONAL HEALTH WELFARE
CANADIAN PAPERS INTERNATIONAL CONFERENCE WATER FOR PEACE
ICWP PAPER 351
DEPT ENERGY, MINES AND RESOURCES OTTAWA ONT
1967 5 P
PUBLICATION TYPE: 3 Report
REF. SOURCE: 0010106 REF. SOURCE NO.: 15044
KEYWORDS: WASTES, INDUSTRIAL WASTES, TREATMENT, WASTE TREATMENT,
OXIDATION, CHEMICAL OXIDATION, WASTE WATER TREATMENT, WASTE
WATER, WATER POLLUTION, PHENOLIC WASTES, DETERGENT WASTES,
EFFLUENTS, WATER POLLUTION SOURCES, PHENOLS

HYDROGEN PEROXIDE HAS BEEN PROPOSED AS A CHEMICAL OXIDANT FOR CYANIDE-BEARING WASTES. WHEN HYDROGEN PEROXIDE IS USED WITH A CATALYTIC AGENT, A MUCH MORE POWERFUL OXIDIZING AGENT RESULTS. A COMBINATION OF HYDROGEN PEROXIDE AND A FERROUS IRON SALT IS KNOWN AS FENTON'S REAGENT. THIS REAGENT HAS NOT PREVIOUSLY BEEN USED FOR TREATING INDUSTRIAL WASTEWATER. THIS PAPER DESCRIBES TWO POTENTIAL APPLICATIONS OF FENTON'S REAGENT INVOLVING THE OXIDATION OF INDUSTRIAL PHENOLIC WASTES AND THE TREATMENT OF WASTEWATER EFFLUENTS CONTAINING SYNTHETIC DETERGENT RESIDUES. 5 REF.

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RANK =    15               -  QL SYSTEMS LIMITED  -          D=   2028  CEN

3595          UPDATE NO.: CENV(A)
BIOLOGICAL CONTROL OF ACID MINE POLLUTION
WALSH F, MITCHELL R
JOURNAL WATER POLLUTION CONTROL FEDERATION
U S DEPARTMENT OF THE INTERIOR WASHINGTON, DC
1972-05 44 5 763-768
PUBLICATION TYPE: 3 Report
REF. SOURCE: WATER MANAGEMEN
US DEPARTMENT OF THE INTERIOR, FWQA TRAINING GRANT
KEYWORDS: MINE DRAINAGE, POLLUTION, WASTE WATER, LIQUID WASTES,
ACIDIC WATER, IRON BACTERIA, MINE ACIDS, MINE WATER, WATER
POLLUTION SOURCES, WATER POLLUTION TREATMENT, ECOLOGY,
ECOLOGICAL SUCCESSION, BACTERIAL SUCCESSION
    THE PURPOSE OF THIS PAPER IS TO DISCUSS A NEW METHOD OF
TREATING ACID MINE WATER.  DATA IS PRESENTED SHOWING THAT UNDER
SYNTHETIC MINE WATER CONDITIONS, A SUCCESSION OF BACTERIA
CAPABLE OF CATALYZING IRON OXIDATION OCCURS AS THE SOLUTION
ACIDITY DECREASES.  BECAUSE THE ACTION OF THESE BACTERIA AFFECTS
THE RATE OF ACID PRODUCTION AND THE LEVEL OF FERRIC IRON IN
EFFLUENT WATERS, AND BECAUSE EACH IRON BACTERIUM IN THE
SUCCESSION CREATES THE CONDITIONS NECESSARY FOR THE NEXT GROUP,
A BREAK IN THIS BACTERIA SUCCESSION MAY PRODUCE A POSITIVE
RESULT IN ACID MINE WATER POLLUTION CONTROL.  THAT IS TO SAY,
SUPPRESSION OF THE ACTIVITY OF AN ORGANISM IN THE IRON BACTERIA
SUCCESSION MAY REDUCE GREATLY THE POLLUTION LEVELS PRESENTLY
REQUIRING END PRODUCT TREATMENT.

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RANK =    16               -  QL SYSTEMS LIMITED  -          D=   1646  CEN

3152          UPDATE NO.: CENV(A)
ACID MINE WASTE TREATMENT USING REVERSE OSMOSIS
GULF ENVIRONMENTAL SYSTEMS COMPANY
WATER POLLUTION CONTROL RES SER
UNITED STATES  PUBLISHED NO.: 14010-DYG08
1971 90
PUBLICATION TYPE: 3 Report
REF. SOURCE: WATER POLLUTION  REF. SOURCE NO.: 1912
U S WATER QUALITY OFFICE
KEYWORDS: ACID MINE DRAINAGE, REVERSE OSMOSIS, IRON COMPOUNDS,
RE-USABLE WATER
    DETAILED RESULTS ARE GIVEN OF PILOT-SCALE STUDIES AT 3
DIFFERENT MINES ON THE USE OF REVERSE OSMOSIS FOR TREATMENT OF
ACID MINE DRAINAGE, BOTH HIGH -FERROUS AND HIGH-FERRIC TYPES.
AT TWO OF THE SITES 80-90 PER CENT OF THE WATER WAS RECOVERED IN
RE-USABLE FORM, BUT AT THE THIRD SITE THE DRAINAGE WATER WAS SO
CONCENTRATED THAT RECOVERIES OF ONLY 50 PER CENT WERE POSSIBLE.
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RANK =      17              - QL SYSTEMS LIMITED -          D=    676  CEN

1612           UPDATE NO.: CENV(A)
NEUTRALIZATION OF HIGH FERRIC IRON ACID MINE DRAINAGE
WILMOTH RC, HILL RD
AFFILIATION: TAFT, (R A) WATER RESEARCH CENTER
WATER POLLUTION CONTROL RESEARCH
U.S. GOVT PRINTING OFFICE  WASHINGTON, DC
1970 38
PUBLICATION TYPE: 3 Report
REF. SOURCE: WATER SECTOR II
U.S. DEPT OF THE INTERIOR. FEDERAL WATER QUALITY ADMINISTRATION
KEYWORDS: RESEARCH AND DEVELOPMENT, WATER POLLUTION,
NEUTRALIZATION, ACID STREAMS, MINE DRAINAGE, HYDROGEN ION
CONCENTRATION, IRON COMPOUNDS, LIME, LIMESTONES, WASTE WATER
TREATMENT, SLUDGE
    LIME, LIMESTONE, AND SODA ASH WERE STUDIED AS NEUTRALIZING
AGENTS FOR TREATMENT OF A FERRIC IRON ACID MINE DRAINAGE WATER.
BOTH CONTINUOUS FLOW AND BATCH TESTS WERE USED TO DETERMINE THE
EFFECTIVENESS OF EACH OF THESE NEUTRALIZING AGENTS IN REACTION
WITH ACID MINE WATER.  COMPARISONS MADE BETWEEN THE THREE
NEUTRALIZING AGENTS INCLUDE:  CHEMICAL COSTS; REACTION
EFFICIENCIES, EFFLUENT WATER QUALITIES, SLUDGE SETTLING RATES,
SLUDGE VOLUMES, AND PERCENT SOLIDS OF SLUDGES.  ALL THREE
NEUTRALIZING AGENTS WERE CAPABLE OF TREATING ACID MINE
DRAINAGE.LIME COSTS WERE HALF THAT OF LIMESTONE FOR TREATING THE
SAME ACID MINE DRAINAGE BECAUSE OF THE LOW UTILIZATION OF
LIMESTONE.  HOWEVER, THE CHARACTERISTICS OF THE LIMESTONE SLUDGE
WERE SUPERIOR TO THOSE OF LIME AND SODA ASH SLUDGES.  THE COST
FOR SODA ASH TREATMENT WAS EXCESSIVE FURTHER RESEARCH ON
IMPROVING LIMESTONE UTILIZATION IS UNDER WAY.  NO DIFFERENCES IN
REACTION EFFICIENCY WERE FOUND IN DRY FEEDING OR SLURRY FEEDING
THE NEUTRALIZATION AGENTS.  AERATION DURING AND/OR AFTER THE
LIMESTONE REACTION MERELY INCREASED THE EFFLUENT PH BUT FAILED
TO.

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RANK =      18              - QL SYSTEMS LIMITED -          D=    782  CEN

1783           UPDATE NO.: CENV(A)
ACID MINE DRAINAGE FORMATION AND ABATEMENT
OHIO-STATE UNIVERSITY RESEARCH FOUNDATION
WATER POLLUTION CONTROL RESEARCH
U.S. GOVT PRINTING OFFICE  WASHINGTON, DC
1971 82
PUBLICATION TYPE: 3 Report
REF. SOURCE: WATER SECTOR II
U.S. ENVIRONMENTAL PROTECTION AGENCY. WATER QUALITY OFFICE
KEYWORDS: ACID MINE WATER, POLLUTION ABATEMENT, OXIDATION,
PYRITE, FERROBACILLUS, MINE WASTES, STRIP MINES, UNDERGROUND

MINING
    THIS REPORT DEALS WITH AT-SOURCE CONTROL OF PYRITE
OXIDATION.  THE CURRENT LEVEL OF KNOWLEDGE ON ACID MINE DRAINAGE
FORMATION IS CRITICALLY REVIEWED, WITH EMPHASIS ON REACTION
KINETICS AND REACTANT AND PRODUCT TRANSPORT.  A REACTION SYSTEM
MODEL IS DEVELOPED WHICH PROVIDES A CONCEPTUAL FRAMEWORK FOR
SUBSEQUENT DISCUSSION DEALING SPECIFICALLY WITH THE PHYSICAL,
CHEMICAL, AND BIOLOGICAL CHARACTERISTICS OF PYRITE SYSTEMS
ENCOUNTERED IN MINING SITUATIONS.  PRACTICAL CONSIDERATIONS OF
AT-SOURCE CONTROL OF ACID MINE DRAINAGE FORMATION IN UNDERGROUND
MINES, SPOIL BANKS, AND REFUSE PILES ARE PRESENTED.  DEFICIENCES
IN CURRENT KNOWLEDGE WHICH ARE BROUGHT OUT BY THIS REPORT
INCLUDE:  DESCRIPTIONS OF THE PHYSICAL ENVIRONMENT EXISTING AT
PYRITE OXIDATION SITES IN NATURAL SYSTEMS ARE FAR MORE
INCOMPLETE THAN THE CURRENT UNDERSTANDING OF PYRITE OXIDATION
KINETICS; OXYGEN TRANSPORT IS POORLY DESCRIBED AT THIS TIME, BUT
IS PROBABLY THE RATE CONTROLLING FACTOR IN MOST INSTANCES;
SERIOUS QUESTIONS EXIST AS TO THE EFFECTIVENESS OF AIR SEALING
TECHNIQUES AS CURRENTLY PRACTICED; THE SIGNIFICANCE OF BACTERIAL
CATALYSIS OF PYRITE OXIDATION UNDER FIELD CONDITIONS HAS NOT
BEEN ESTABLISHED.
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57506 UPDATE NO.: CENV82(4)
Mine wastewater pilot treatment project (metals removal)
SHIRLEY P
AFFILIATION: Brunswick Min Smelting Corp Ltd
Technology Transfer Seminar on Mining Effluent Regulations/ Guidelines and Effluent Treatment Technology as Applied to the Base Metal, Iron Ore and Uranium Mining and Milling Industry, Seminar notes, Sudbury, Ont, November 5-6, 1975, Montreal, Que, November 17-18, 1975, Banff, Alta, December 9-10, 1975
nd 16p 5 tab LANG.: En
PUBLICATION TYPE: 4 Conference paper
REF. SOURCE: 0010901 REF. SOURCE NO.: WATDOC 57504
NOTES: Seminar sponsored by Environ Prot Serv, Environ Can and the Can Inst Min Metall; This report is a summary of a report by the same title compiled by Montreal Eng Co Ltd
KEYWORDS: mine wastes, pilot plants, wastewater treatment, copper, zinc, lead, iron, hydrogen ion concentration, sludge, metals, dewatering, acid mine drainage, effluent quality, reagents, barium sulphide, filtration, recycling

Conventional mechanized treatment is capable of meeting Proposed National Levels for Cu and Zn without polishing. Pb levels achieved were slightly higher than recommended for national acceptance. For levels lower than the Proposed National, some polishing scheme must be considered. Within reasonable limits, reaction times, pH fluctuations and initial drainage strength have little effect on effluent quality. Process sensitivity is overwhelmingly related to liquid/solids separation. Proper selection, preparation and addition of flocculant is essential. High density sludge was produced from all three drainages using the High Density Sludge Process. Effluent quality was apparently unaffected except insofar as the increased solids loading influenced the liquid/solids separation. Sludge dewatering using conventional vacuum filtration equipment should be feasible. Filter leaf tests on freshly produced sludge were characterized by good pick-up, drainage and discharge properties.

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57506 UPDATE NO.: CENV82(4)
Prediction of acid generation potential
DUNCAN DW, WALDEN CC
AFFILIATION: BC Res Ltd
Technology Transfer Seminar on Mining Effluent Regulations/Guidelines and Effluent Treatment Technology as Applied to the Base Metal, Iron Ore and Uranium Mining and Milling Industry, Seminar notes, Sudbury, Ont, November 5-6, 1975, Montreal, Que, November 17-18, 1975, Banff, Alta, December 9-10, 1975
Water Pollut Control Dir, Environ Prot Serv, Environ Can
1975-11 18p 3 tab LANG.: En
PUBLICATION TYPE: 4 Conference paper
REF. SOURCE: 0010501 REF. SOURCE NO.: WATDOC 57504
NOTES: Seminar sponsored by Environ Prot Serv, Environ Can and the Can Inst Min Metall
KEYWORDS: acids, testing procedures, evaluation, mine wastes, sulfides, sulphides, liquid wastes, estimating, bacteria, sulphuric acid, sulfuric acid, oxidation, Thiobacillus ferrooxidans, minerals, acid mine drainage, experimental data, metals, data interpretation, microbiological studies, hydrogen ion concentration

A procedure for determining the net acid generating potential of sulphide minerals and wastewaters has been developed and verified. Part I deals with the measurement of acid production potential. The test, developed by B.C. Research, consists of two phases. In the initial or chemical phase, it is determined whether the sample contains enough sulphides to theoretically produce more sulphuric acid than the sample itself can neutralize. If this test indicates that there is a potential danger of excess acid production, then the microbiological or confirmatory portion of the test is carried out to determine if the bacteria can actually produce excess sulphuric acid from the sample in question. Part II deals with the verification of acid production potential. A total of 16 composite tailings samples of low, medium and high sulphur content were submitted for testing. Nine were theoretical sources of excess sulphuric acid. The confirmation test showed that bacteria could produce excess sulphuric acid from 8 of these 9 samples. It is not definitely known why the other sample, tailings from a tungsten mill containing 12.1% sulphur, did not produce excess acid. The acid consumption of the liquid portion of the samples was negligible compared to that of the solids.

42361 UPDATE NO.: CENV(A)
MINING AND MILLING IN BRITISH COLUMBIA
NEMETZ PN
PRACT APPL ECON INCENTIVES CONTROL POLLUT: THE CASE OF BC
UNIV BC PRESS VANCOUVER, BC
1974 105-159
PUBLICATION TYPE: 2 Book
REF. SOURCE: 0010501
KEYWORDS: MINING, MILLING, MINE EFFLUENTS, WATERBORNE RESIDUALS, COPPER, LEAD, ZINC, MOLYBDENUM, SEDIMENT, BIOLOGICAL SYSTEMS, WATER POLLUTION, PROCESS WATER, WASTE ROCK, MINE WATER DISPOSAL, TAILINGS, MINE DISCHARGES, SILT, ACID MINE DRAINAGE, DISSOLVED METALS, METAL SULPHIDE MINERALS, WATER QUALITY

THIS PAPER WAS PRESENTED AT THE CONFERENCE ON ECONOMIC INCENTIVES FOR AIR AND WATER POLLUTION CONTROL, VICTORIA, 1974. IT IS FOUND IN THE BOOK ENTITLED THE PRACTICAL APPLICATION OF ECONOMIC INCENTIVES TO THE CONTROL OF POLLUTION: THE CASE OF BRITISH COLUMBIA, JAMES B. STEPHENSON (EDITOR). THE PURPOSE OF THIS ARTICLE IS TO EXAMINE BRIEFLY THE APPLICABILITY OF SEVERAL LEGAL-ECONOMIC MECHANISMS TO THE MANAGEMENT OF WATERBORNE RESIDUALS IN THE MINING INDUSTRY OF BRITISH COLUMBIA. THIS ARTICLE WILL FOCUS ON RESIDUALS GENERATION ASSOCIATED SPECIFICALLY WITH MINE-MILL COMPLEXES CURRENTLY PRODUCING BRITISH COLUMBIA'S FOUR MAJOR METALS (I.E., COPPER, LEAD, ZINC, AND MOLYBDENUM). THE DISCUSSION OF THE ENVIRONMENTAL IMPACT OF METAL CONCENTRATES IN THE NEXT STAGE OF PROCESSING (I.E., SMELTING AND REFINING) IS LEFT TO ANOTHER ARTICLE IN THIS VOLUME. THE TEXT IS DIVIDED INTO THE FOLLOWING SECTIONS: CURRENT EFFLUENT AND AMBIENT LEVELS OF RESIDUALS; DESCRIPTION OF THE COSTS AND EXTENT OF POLLUTION CONTROL IN THE BRITISH COLUMBIA MINING INDUSTRY; PRINCIPAL LEGAL-ECONOMIC MECHANISMS UNDER EXAMINATION; APPLICABILITY OF THESE MECHANISMS TO THREE DISTINCT MINING SITUATIONS IN BRITISH COLUMBIA; SPECIFIC EXAMPLES; AND SUMMARY. 3 APP, 5 FIG.

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57510 UPDATE NO.: CENV82(4)

Some notes on the subject of integrated mine wastewater system design and selection

BELL AV

AFFILIATION: Semour Environ Div, Montreal Eng Co Ltd, 591 King St, Fredericton, NB

Technology Transfer Seminar on Mining Effluent Regulations/Guidelines and Effluent Treatment Technology as Applied to the Base Metal, Iron Ore and Uranium Mining and Milling Industry, Seminar notes, Sudbury, Ont, November 5-6, 1975, Montreal, Que, November 17-18, 1975, Banff, Alta, December 9-10, 1975

nd 10p 1 plate, 1 tab, 2 app LANG.: En

PUBLICATION TYPE: A Conference paper

REF. SOURCE: 0010901 REF. SOURCE NO.: WATDOC 57504

NOTES: Seminar sponsored by Environ Prot Serv, Environ Can and the Can Inst Min Metall

KEYWORDS: mine wastes, wastewater treatment, planning, design, wastewater management, mills, pilot plants, effluents, acid mine drainage, tailings ponds, economic aspects, hydrogen ion concentration, sludge, lead, zinc, copper, iron

In the planning and design of mining wastewater systems it is essential that the interrelationships between the various waste components and the mine/mill process operations are recognized and taken into account. Waste management planning should be included at the earliest possible stages of project development and continued at a level consistent with the general project development activities. In this way the best overall economic balance for the project as a whole, consistent with meeting effluent and other requirements can be sought and therefore the incremental cost of waste management measures minimized. Two papers by A.V. Bell on aspects of waste treatment are included as appendices to this paper.

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RANK =     23              - QL SYSTEMS LIMITED -         D=  30991  CEN

36601          UPDATE NO.: CENV(A)
FLOCCULATION OF NEUTRALIZED MINE DRAINAGE WITH POLYMERS
HUCK PM, MURPHY KL
AFFILIATION: DEP CHEM ENGINEERING, MCMASTER UNIV, HAMILTON, ONT
WATER POLLUTION RESEARCH IN CANADA 1976 WPRC-A
1976 011 46-56
PUBLICATION TYPE: 1 Article
REF. SOURCE: 0010501
KEYWORDS: POLYMERS, OPTIMUM MIXING CONDITIONS, ACID MINE
DRAINAGE, WASTE TREATMENT, FLOCCULATION, FERRIC HYDROXIDE,
MINEWATERS, PROCESSES, HYDROLYSIS, LOCAL OPTIMUM, IRON

CONCENTRATION, SULPHATES, MECHANISTIC MODELLING
    METAL BEARING WASTEWATERS SUCH AS BASE METAL MINE DRAINAGE
ARE CONVENTIONALLY TREATED WITH LIME TO PRECIPITATE THE METALS
AS HYDROXIDES. ALTHOUGH THE ADDITION OF A SYNTHETIC POLYMER HAS
BEEN FOUND TO AID CLARIFICATION IN THIS PROCESS, NO RATIONAL
METHODOLOGY EXISTS FOR THE DETERMINATION OF OPTIMUM FLOCCULATION
CONDITIONS. USING TAILORED POLYACRYLAMIDE, THE PRESENT RESEARCH
EXAMINED THE EFFECTS OF POLYMER PROPERTIES AND MIXING CONDITIONS
ON SUPERNATANT PARTICULATE IRON CONCENTRATIONS FOR SYNTHETIC
MINEWATERS CONTAINING VARIOUS INITIAL CONCENTRATIONS OF THAT
METAL.  IT WAS FOUND THAT MIXING CONDITIONS WERE MORE IMPORTANT
THAN POLYMER PROPERTIES IN PRODUCING OPTIMUM BEHAVIOUR.  OPTIMUM
RAPID MIX SPEED APPEARED TO BE PROPORTIONAL TO MINEWATER
STRENGTH, WHILE FLOCCULATION TIME VARIED INVERSELY WITH
STRENGTH.  THE SYSTEM WAS SENSITIVE TO POLYMER DEGREE OF
HYDROLYSIS BUT NOT TO DOSAGE.  AT PH 9.5, RESIDUAL TOTAL IRON
CONCENTRATIONS BELOW 0.2 MG PER L WERE ACHIEVED.  MECHANISTIC
MODELLING USING THE FLOCCULATION EQUATION WAS SUCCESSFUL.  12
REF, 8 TAB, 4 FIG.
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RANK =     24              - QL SYSTEMS LIMITED -         D=    590  CEN

1803           UPDATE NO.: CENV(A)
EVALUATION OF PYRITIC OXIDATION BY NUCLEAR METHODS
BAKER WA
AFFILIATION: MELLON INSTITUTE, CARNEGIE-MELLON UNIVERSITY
WATER POLLUTION CONTROL RESEARCH
U.S. GOVT PRINTING OFFICE  WASHINGTON, DC
1971
PUBLICATION TYPE: 3 Report
REF. SOURCE: WATER SECTOR LI
ENVIRONMENTAL PROTECTION AGENCY. WATER QUALITY OFFICE
KEYWORDS: MINE DRAINAGE, WATER POLLUTION EFFECTS, MINE WASTES,
COAL MINES, PYRITE, IRON, COBALT, SPECTROSCOPY, OXIDATION
    THE OBJECTIVE OF THIS RESEARCH WAS TO DEMONSTRATE THE
FEASIBILITY OF USING THE MOSSBAUER EFFECT AND BACKSCATTERING
MODE DETECTION OF 14-4 KEVGAMMA RAYS TO SPECTROSCOPICALLY MONITOR
PYRITIC OXIDATION.SUCCESSFUL DEMONSTRATION WILL PROVIDE A
VALUABLE TECHNIQUE FOR DEFINING THE NATURE OF THE OXIDATION
PROCESS. SUCH KNOWLEDGE IS NECESSARY IF PRATICAL METHODS OF
ELIMINATING OR RESTRICTING ACID MINE DRAINAGE FORMATION ARE TO
EVOLVE.IN THE STUDY, A COBALTOUS OXIDE FORM OF COBALT-57 WAS THE
RADIATION SOURCE.SPECTRA WERE OBTAINED OF PYRITIC SURFACES UNDER
2MM OF WATER.DIFFERENTIATION OF NONOXIDIZED AND OXIDIZED PYRITIC
SURFACES WAS POSSIBLE WITH FURTHER SEPARATION OF THE SPECTRA TO
SHOW INDIVIDUAL OXIDATION PRODUCT PEAKS SUGGESTING FERRIC
HYDROXIDE AND FERRIC SULFATE.
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51524 UPDATE NO.: CENV81(8)
The physical limitations to vegetation establishment of some southern British Columbia mine waste materials.
MORTON JB
Univ BC, Vancouver, BC
1976-04 116p 1 app, 15 tab, 10 fig, 8 plates, 52 ref LANG.: En
PUBLICATION TYPE: 6 Thesis
REF. SOURCE: 0011ABA REF. SOURCE NO.: LE3 B7 1976 A67 M67
NOTES: MSc Thesis, Dep Soil Sci
GEOGRAPHIC ID.: W120 30,N49 22
KEYWORDS: British Columbia, mill tailings, vegetation, mine wastes, Princeton, Kimberley, Highland Valley, revegetation, mine waste properties, aeration, water storage, cation exchange capacity, grasses, conifers

Vegetation establishment on mine wastes is ultimately limited by the edaphic properties of the wastes. This thesis examines, characterizes and interprets the physical properties of some southern British Columbia mine wastes: to elucidate the feasibility of various reclamation procedures. Waste areas, including both mill tailings, rock dumps and adjacent natural soils are characterized. The project primarily addresses three areas in British Columbia affected by sulfide mining activities; the Princeton area, the Highland Valley area and the Kimberley area. Waste materials examined were derived from the Similkameen, Copper Mountain, Lornex, Bethlehem and Sullivan mines. Minor examination of the now revegetated Jersey Mine tailings located near Salmo, B.C. was also included. Field work involved mapping waste materials and natural soils and then systematically sampling the various units delineated. Laboratory methods were employed to define and compare the properties of samples collected. Limited water storage capacity was found to be a major problem in waste rock dump material. Mill tailings were found to have acceptable available water storage capacities. Some mill tailings may have aeration porosity deficiencies when wet. Cation exchange capacities, while usually adequate in waste rock dump materials, are sometimes very low in mill tailings; a factor that will present serious fertility problems in revegetation. Some adjacent coarse coniferous forest soils were found to have similar properties to waste rock dump material while some adjacent grass dominated soils were found to have similar properties to the mine tailings. Waste rock dump material appears best suited to eventual revegetation by aborescent species, while mill tailings appear best suited to eventual revegetation by grass or forb species. Soil processes were found to be both active and rapid in both types of waste material.

63981 UPDATE NO.: CENV83(5)
Asbestos residue - an untapped resource
Une richesse inexploite, les residues d'amiante
AITCIN P-C
AFFILIATION: Dep Civ Eng, Univ Sherbrooke, Sherbrooke, Que
Geos, Energy, Mines Resour, 580 Booth St, Ottawa, Ont K1A 0E4
PUBLISHER NO.: ISSN 0374-3268
(1981) 6p LANG.: Fr-En
PUBLICATION TYPE: 3 Report
REF. SOURCE: 005C201
NOTES: Translated from Geos Vol 10 No 3, p10-12, ISSN 0374-3268; Translations are available from Editor, Geos, EMR, 580 Booth St, Ottawa, Ont K1A 0E4
GEOGRAPHIC ID.: W71 18,N46 05;W71 56,N45 46
KEYWORDS: Thetford Mines, Asbestos, Quebec, asbestos residue, mine wastes, brucite, magnesium oxide, silica, iron oxide, minerals, calcination, magnetic separation process, waste recovery, industrial wastes

Asbestos residue has been accumulating for a century in the producing regions of Quebec, mainly in Asbestos and Thetford Mines. However, only recently has attention been focussed on developing methods of utilization of this waste. The serpentinite which is found in the mining basins of Asbestos and Thetford Mines was formed by hydrothermal alteration of a pre-existing deposit of olivine. The following chemical compounds form the basis of the asbestos residue: magnesium oxide, silica, water and iron oxide. Asbestos tailings consist of the following three principal minerals: serpentine, brucite and magnetite. Also found in the residues are metal compounds containing chromium, nickel, traces of cobalt, silver and gold. Some possible uses for the raw residue are described including use in the manufacture of various products and in certain industrial processes. After calcination, the residues may be used in preparation of aggregates for concrete, lightweight aggregates, fertilizer, and as a filler for plastics. Recently, researchers at the Centre de Recherche Minerale du Quebec perfected a magnetic separation process whereby almost all of the iron and chromium found in the residue may be separated into two parts: one a magnetic concentrate rich in iron oxide, and the other a non-magnetic fraction with an iron-oxide content of less than two or three per cent. This new process will open many new avenues to industry.

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RANK = 27 - QL SYSTEMS LIMITED - D= 47320 CEN

53028 UPDATE NO.: CENVR1(9)
Surface stabilization of tailing disposal areas at Wabush Mines, Labrador
MCEWEN EL
AFFILIATION: Wabush Mines, Wabush, Labrador

CIM Bull CIBUBA
ISSN 0317-0926
1981-05 74(829) 86-88 5 photo LANG.: En
PUBLICATION TYPE: 1 Article
REF. SOURCE: 0010501
GEOGRAPHIC ID.: W66 52,N52 55
KEYWORDS: Wabush Mines, Labrador, open-pit mining, tailings, mine wastes, waste disposal, reclamation, vegetation, soils, dusts, stabilization, equipment, iron ore, environment effects

The objectives of the Wabush Mines tailings stabilization program are to control dust lift-off and to rehabilitate the disposal area. The evolution of the program started with test plots in 1970, these being continued and expanded upon through 1974. In 1976, a 35-acre vegetation field trial was attempted and failed, part of the failure being attributed to lack of adequate equipment. Subsequently, equipment was purchased and during the summer of 1979-80 extensive areas were treated. The program was also expanded to include the evaluation of chemical and water spray stabilization versus vegetation in areas where shorter-term control is required. In addition, during the summers of 1979-80, spruce bog material was spread over about 100 acres and seeded. The approach to reclamation by vegetation at Wabush is one of soil building. Work to this point indicates that iron ore tailings can be converted to a soil capable of supporting plants. Plans for the Wabush tailings disposal area should make dust lift-off from inactive tailings areas negligible within the next few years.

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50130 UPDATE NO.: CENVR1(6)
A summary of possible environmental effects of disposing mine tailings into Strathcona Sound, Baffin Island
HATFIELD CT, WILLIAMS GL
AFFILIATION: Hatfield Consult Ltd, 4394 Gallant Ave, North Vancouver, BC V7G 1L2
ALUR 75-76-38 (North of 60)
Indian North Aff, Ottawa, Ont PUBLISHER NO.: QS-8115-000-EE-A1
1976 76p 2 app, 188 ref, 3 tab, 11 fig LANG.: En
PUBLICATION TYPE: 3 Report
REF. SOURCE: 0011201 REF. SOURCE NO.: CWS 765
NOTES: On file with Environ Can, Can Wildl Serv, Ottawa, Ont K1A 0E7
GEOGRAPHIC ID.: W84 30,N73 00
KEYWORDS: Baffin Island, Strathcona Sound, environmental effects, food chains, mine wastes, waste disposal, heavy metals, zinc, lead, Pb, cadmium, copper, iron, arsenic, fjords, toxicity, native peoples, marine biology, alternate planning, alternative planning

This report is a "desk" evaluation of the possible effects on the marine environment of disposing tailings into the sea from the Nanisivik Mine being developed on Strathcona Sound, Baffin Island. It is not an environmental impact study, but rather a summary of information on what is known to date about the environment at the site, the use local people make of it, and the effects of heavy metal pollution on living systems. The mine is to produce tailings containing zinc, lead, cadmium, copper, iron and arsenic. It is proposed to pipe the tailings to deep waters of the Sound for disposal because the extremely steep terrain and permafrost in the area make construction of conventional tailings lagoons difficult and costly. Heavy metals have relatively high toxicities to the living environment and generally bioaccumulate in animals. Cadmium, arsenic, lead and zinc in particular, affect marine life by directly killing the organisms or in some cases contaminating the animals to levels which make their flesh unfit for human consumption. Information from mines having marine disposal systems in Greenland and Vancouver Island is summarized. On the basis of present local environmental data on the area and scientific data on heavy metal pollution it is concluded that the tailings will probably contaminate the living environment in the area with heavy metals to significant levels if they are put into Strathcona Sound. Food sources for local people in the area could also be adversely affected. On the basis of the present level of information on the biological and physical dynamics of the fjord, scientific knowledge of the long-term effects of heavy metals on the living environment, and probable dangers of cadmium bioaccumulation in local marine life and man, it is concluded that the mine tailings should not be deposited into Strathcona Sound. Possible alternate solutions for the disposal of tailings from the mine are outlined and recommendations for further studies listed.

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BANK = 29 - QL SYSTEMS LIMITED - D= 37822 CEN

43524 UPDATE NO.: CENV(A)
WATER POLICY AT INCO METALS COMPANY ONTARIO DIVISION MILLS
BUTLER HS
AFFILIATION: ENVIRON CONTROL, ONT DIV, INCO METAL CO, SUDBURY, ONT
CANADIAN MINING JOURNAL CAMJ-A
1980-03 101 003 23
PUBLICATION TYPE: 1 Article
REF. SOURCE: 0010501
KEYWORDS: INCO METALS COMPANY, SUDBURY, ONTARIO, WATER REUSE, WATER RECYCLING, INDUSTRIAL WASTES, WASTE DISPOSAL, TAILINGS, WATER TREATMENT, THUNDER BAY, LAKE SHEBANDOWAN, PORT COLBORNE, EFFLUENTS, RECIRCULATED WATER, WATER QUALITY

THE ONTARIO DIVISION OF INCO METALS COMPANY, A UNIT OF INCO LIMITED, OPERATES 11 MINES, FOUR MILLS, THREE REFINERIES, ONE SMELTER AND ONE IRON ORE RECOVERY PLANT. ALL BUT ONE MINE, MILL AND REFINERY ARE LOCATED WITHIN A 50-KM RADIUS OF SUDBURY ONTARIO. A MINE-MILL COMPLEX IS LOCATED SOME 100 KM WEST OF THUNDER BAY ON THE SHORE OF LAKE SHEBANDOWAN AND A NICKEL REFINERY AT PORT COLBORNE. THE AUTHOR DISCUSSES THE USE OF RECYCLED WATER IN MILLING OPERATIONS. THE HIGH DEGREE OF WATER REUSE HAS REDUCED (1) THE NEED FOR FRESH WATER AND (2) THE CONTAMINANT LEVEL OF THE DOWNSTREAM AQUATIC ENVIRONMENT. WASTE DISPOSAL AND WATER TREATMENT ARE DISCUSSED. 2 TAB, 1 PHOTO

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BANK = 30 - QL SYSTEMS LIMITED - D= 11769 CEN

15500 UPDATE NO.: CENV(A)
MINE WATER PURIFICATION BY REVERSE OSMOSIS
ROSEHART RG
AFFILIATION: SCHOOL OF ENGINEERING, LAKEHEAD UNIV, THUNDER BAY, ONTARIO
LAKEHEAD UNIVERSITY, SCHOOL OF ENGINEERING THUNDER BAY ONT
1972-09 17 P
PUBLICATION TYPE: 3 Report
REF. SOURCE: 0010104 REF. SOURCE NO.: 15500
KEYWORDS: MINE WATER, WATER QUALITY, REVERSE OSMOSIS, WASTE WATER TREATMENT, PILOT PLANT, MEMBRANES, COPPER, IRON, ZINC, NICKEL, ARSENIC, CYANIDE, MINE WASTES

A SMALL ONE GALLON PER MINUTE REVERSE OSMOSIS PILOT PLANT HAS BEEN CONSTRUCTED, USING COMMERCIALLY AVAILABLE CALGON AND DUPONT MEMBRANES. THE UNIT OPERATES AT PRESSURES UP TO 600 PSI AND IS PORTABLE. THE PROCESSING UNIT HAS BEEN USED IN AN ATTEMPT TO PURIFY MINE WASTE WATER FROM MATERIALS SUCH AS CU, FE, ZN, NI, ARSENIC AND CYANIDE. NATURAL MINERAL WATERS HAVE BEEN USED FOR ALL OF THE STUDIES. THE EFFECTIVENESS OF THE TREATMENT IS DISCUSSED AS WELL AS THE ECONOMICS OF THE REVERSE OSMOSIS PROCESS. 5 TABLES, 7 FIG., 4 REF.

60057 UPDATE NO.: CENV83(1)
The disposal of solid wastes and liquid effluents from the
milling of uranium ores
MOFFETT D
AFFILIATION: Min Res Lab, Can Cent Miner Energy Technol, Dep
Energy Mines Resour, Elliot Lake, Ont
CANMET Rep 76-19
CANMET, Energy Mines Resour Can, 555 Booth St, Ottawa, Ont K1A

0G1 ISBN 0-660-00909-9 PUBLISHER NO.: M38-13/76-19
1977 76p 10 fig, 18 tab, 66 ref LANG.: En
PUBLICATION TYPE: 3 Report SCI.: CCPP
REF. SOURCE: 0010501 REF. SOURCE NO.: TN1 C32 No76-19
GEOGRAPHIC ID.: NB2 40,N46 23
KEYWORDS: Uranium ore, mine wastes, radioactive waste disposal,
radioactive wastes, liquid wastes, effluents, radium
radioisotopes

Current Canadian practice in the milling of uranium-bearing ores commonly involves fine grinding followed by acid leach/ion exchange. The acid leach may be followed instead by solvent extraction. Alkaline leaching has been done, and in situ bacteriological leaching is of interest. Tailings disposal operations are necessary and create environmental problems. Uranium-mill wastes are unique because of their radioactivity. Some of the radioisotopes present may require an individual control procedure. Radium-226 is particularly important because it is the most hazardous of all isotopes found in the tailings. Acid and heavy-metal removal is conventionally done by the addition of lime, but other means are available, such as with limestone, sodium hydroxide, ammonia, silicon alloys or by sulphide precipitation. Modifications to unit operations in the mill process may be required to produce more acceptable effluents. Increased water recycling may be necessary to meet regulatory standards.

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53964 UPDATE NO.: CENY82(1)

Permafrost spatial and temporal variations near Schefferville,
Nouveau-Quebec

NICHOLSON FH

AFFILIATION: Dep Geogr, City Liverpool, Coll Higher Education,
Prescot, Merseyside L34 1NP, UK
Geogr phys quat
ISSN 0705-7199
1979 33(3-4) 265-277 Les Presses de l'Univ Montreal, Que LANG.:
En24 ref, 6 tab, 12 fig
PUBLICATION TYPE: 1 Article
REF. SOURCE: 0080101
GEOGRAPHIC ID.: W66 50,N54 48
KEYWORDS: Schefferville, Nouveau-Quebec, permafrost, spatial
variations, temporal variations, frozen ground, frozen soils,
Arctic, climatology, iron mines, thermal regime, heat balance

Specially detailed studies of permafrost have developed at Schefferville because of the availability of long term data and the economic stimulus of the effect of permafrost on the iron mines. Knowledge of the three dimensional distribution of permafrost has been greatly expanded and energy budget studies have given confidence to many aspects of interpretation.

Although the mean annual temperatures are -5 to -6.5 degrees, large areas remain free of permafrost due to the winter insulation provided by deep snow drifting which accumulates where snow drifting is subdued (e.g. in woodland). There are large year to year variations of frozen ground temperature in the upper 25m (due to variations of snow conditions) and active layer depth (related to variations of summer weather conditions). Suprapermafrost ground water movement is often concentrated along specific channels and transported heat causes very deep active layers (up to 12m) or even maintains unfrozen zones (up to 30m). On simple sites the active layer is primarily related to % vegetation cover, with mean depth ranging from 2.3 m under 100% vegetation to 3.6 m under bare ground. Considerable effort has been devoted to quantifying snow data for permafrost prediction and good results have been obtained from quantititavely relating ground temperatures to snow and a simulated groundwater measure. The permafrost is generally in balance with the present climate and new permafrost has developed in mine waste dumps.

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BANK = 33 - CL SYSTEMS LIMITED - D= 46669 CEN

52376 UPDATE NO.: CENV81(9)
Like it or not, consultants must show concern for the environment
PORTEOUS EA
AFFILIATION: Hydraul Div, Klohn Leonoff Consult Ltd, Richmond, BC
Can Consult Eng CCEG-8
ISSN 0008-3267
1980-03 22(3) 36-38 2 photo, 1 map LANG.: En
PUBLICATION TYPE: 1 Article
REF. SOURCE: 0010501
KEYWORDS: arctic, environmental effects, permafrost, mine wastes, waste disposal, pipelines, thermal powerplants, thermal pollution, environmental engineering, ecology

The writer's company has dealt with environmental effects of civil engineering projects for nearly 30 years. Two main areas have been arctic work, and mine tailings disposal. Since 1969 the firm has been involved in studies for 3 major arctic pipelines, for Northern Canada Power Commission thermal power plants and the Aishihik power canal. Permafrost degradation, erosion of fine grained soils, sedimentation of drainages, thermal erosion and potential slope instability are some of the environmental concerns. A major design consideration for dams constructed of mine tailings, is the prevention of liquifaction of saturated tailings during an earthquake. The tailings can pollute the water, as at the Quebec Cartier Mines on the Quebec-Labrador border, where the tailings colour the water red. Other projects include a flood planning study for Drumheller, Alberta; construction and monitoring of tailings storage for Reserve Iron Mine in Minnesota; assessment of a proposed open pit molybdenum mine in northern British Columbia. The company is convinced that environmental aspects must form an integral part of design studies undertaken by engineering firms.

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BANK = 34 - CL SYSTEMS LIMITED - D= 1364 CEN

2824 UPDATE NO.: CENV(A)
PILOT-SCALE STUDY OF ACID MINE DRAINAGE
OHIO STATE UNIVERSITY
WATER POLLUTION CONTROL RES SER
U S PRINTING OFFICE WASHINGTON, D C PUBLISHED NO.: 14010EEA 03171
1971 92
PUBLICATION TYPE: 3 Report
REF. SOURCE: WATER POLLUTION REF. SOURCE NO.: 1909
U S WATER QUALITY OFFICE
KEYWORDS: PILOT PLANTS, PYRITE OXIDATION, MINE DRAINAGE, ACID MINE WATER OXYGEN CONTENT, ACID PRODUCTION

PILOT-SCALE STUDIES ARE BEING CARRIED OUT AT A SMALL ABANDONED DRIFT MINE ON PYRITE OXIDATION AND THE RESULTING ACID MINE DRAINAGE, INCLUDING THE EFFECT OF OXYGEN CONCENTRATION ON ACID PRODUCTION. THE RESULTS INDICATE THAT THE MAJOR REACTION SITES ARE LOCATED ABOVE THE GROUND-WATER TABLE WHERE GAS RATHER THAN LIQUID IS THE CONTINUOUS PHASE. THERE IS NO EVIDENCE OF SIGNIFICANT BACTERIAL CATALYSIS OF PYRITE OXIDATION.

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BANK =     35             -  CL SYSTEMS LIMITED  -         D=   1208  CEW

2656            UPDATE NO.: CENV(A)
ABATEMENT OF POLLUTION FROM MINE WASTE WATERS
SCHMIDT JE
CANADIAN MINING JOURNAL
1969 90 6 54-60
PUBLICATION TYPE: 3 Report
REF. SOURCE: WATER POLLUTION  REF. SOURCE NO.: 1695
KEYWORDS: TAILINGS, METAL MINE, ACIDITY, CHEMICAL PRECIPITATION,
CALCIUM CARBONATE, SULPHUR ACID, CHEMICALLY-OXIDIZED SULPHITE,
THIOSULPHATE, THIOBACILLUS FERRO-OXIDANS, THIONATE, IRON, ORE
PROCESSING WASTE WATER, SULPHUR COMPOUNDS, SULPHATE
    STUDIES ON A STREAM RECEIVING TAILINGS POND DISCHARGE FROM A
METAL MINE SHOWED A SHARP INCREASE IN ACIDITY DOWNSTREAM FROM
THE MINE; THIS IS ATTRIBUTED TO PRECIPITATION OF CALCIUM

CARBONATE AND PRODUCTION OF SULPHURIC ACID FROM PRODUCTS OF
CHEMICALLY-OXIDIZED SULPHITE AND THIOSULPHATE. THIOBACILLUS
FERRO -OXIDANS FOUND IN THE STREAM UTILIZED THIONATE (THE MAJOR
ANION IN THE DISCHARGE) IN PREFERENCE TO IRON.  IT IS
RECOMMENDED THAT THE ORE PROCESSING WASTE WATERS SHOULD BE
TREATED TO GIVE STABLE SULPHUR COMPOUNDS IN THE SULPHATE FORM.

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BANK =     36             -  CL SYSTEMS LIMITED  -         D=  57490  CEN

63204           UPDATE NO.: CENV83(8)
The occurrence of Thiobacillus ferrooxidans and arsenic in
subarctic streams affected by gold-mine drainage
BROWN EJ, LUONG HV, FORSHAUG JM
AFFILIATION: Inst Water Resour, Univ Alaska, Fairbanks, AK 99701
US
Arctic ATICAE
ISSN 0004-0843
1982-09 35(3) 417-421 1 fig, 2 tab, 16 ref  LANG.: En
PUBLICATION TYPE: 1 Article  SOL.: COPP
REF. SOURCE: 0010501
KEYWORDS: Alaska, Yukon Territory, subarctic zone, mine
drainage, gold mines, arsenic, streams, dissolved oxygen, heavy
metals, Thiobacillus ferrooxidans, pyrite, minerals,
microorganisms, bacteria, hydrogen ion concentration, water
quality, water sampling, environmental effects
    Thirty-five streams in gold-mining regions between Rampart,
Alaska, and Dawson City, Yukon Territory, were sampled to
determine dissolved arsenic concentrations, and numbers of the
acidophilic iron- and sulfur-oxidizing bacterium Thiobacillus
ferrooxidans. The pH of the streams varied from 6.3 to 8.6 and
the streams were nearly saturated with dissolved oxygen.  T.
ferrooxidans was found in eight of nine streams affected by
gold-mine drainage and in only one of 26 streams not affected by
gold-mine drainage. Some of the streams affected by gold-mine
drainage near Fairbanks, Alaska, occasionally contained levels
of dissolved arsenic above 50 parts per billion.  The
recognition that T. ferrooxidans is associated with gold-mine
material and that the heavy metal arsenic exists in streams
affected by gold-mine wastes is important for understanding the
environmental effects of mining activity on subarctic streams.

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RANK = 37 - CL SYSTEMS LIMITED - D= 53775 CEN

59485 UPDATE NO.: CENV82(7)

Treatment of Giant Yellowknife effluents
PRICE LS
AFFILIATION: Falconbridge Nickel Mines Ltd
Cyanide and the gold mining industry, Environ Can Tech Semin, Ottawa, Ont, Jan 1981
1981 10p 12 ref, 3 tab, 4 fig LANG.: En
PUBLICATION TYPE: 4 Conference paper
REF. SOURCE: 0010901 REF. SOURCE NO.: NATDCC
GEOGRAPHIC ID.: W114 21,N62 27
KEYWORDS: Northwest Territories, Giant Yellowknife Mines Limited, mine wastes, effluents, cyanide, wastewater treatment, gold mines, arsenic

In 1976 a joint government-industry program was initiated with Giant Yellowknife Mines Limited, to demonstrate the feasibility of removing cyanide and arsenic from gold milling effluents. The results were technically suitable but expensive. Following the pilot plant work Giant investigated several other approaches but concluded in early 1980 that no other technology was ready for immediate commercial use. The water license issued in 1978 called for major effluent quality improvement by May 1981. To meet this a plant has been designed to treat the full flow of tailings pond overflow, using alkaline chlorination and iron salts precipitation, at a final cost of $1.5 million. Annual operating cost will be $400,000. At Giant Yellowknife Mines Limited, gold in the ore is mainly locked in a fine grained arsenopyrite (FeAsS).

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RANK = 38 - CL SYSTEMS LIMITED - D= 55805 CEN

61516 UPDATE NO.: CENV83(4)
Industrial surface runoff survey, McIntyre Mines Ltd., Grande Cache, conducted: April 15, 1976, May 18, 19, 1976
DOWHANIUK E
Alberta Environ, Pollut Control Div, Water Qual Control Branch
(1976) 18p 1 app, 3 tab, 1 fig LANG.: En
PUBLICATION TYPE: 3 Report SCL.: AEEN
REF. SOURCE: 2010101 REF. SOURCE NO.: TD897 A4 M15 A333
KEYWORDS: Grande Cache, Sheep Creek, Alberta, McIntyre Mines Limited, industrial wastewater, surveys, suspended solids, licences, water quality standards, effluents, evaluation, iron, settling basins, wastewater analysis, wastewater treatment, surface runoff

A water quality survey was conducted April 15 and May 18 and 19, 1976 at McIntyre Mines Limited, Grande Cache. The results of the survey were used to make an evaluation of the runoff ponds effectiveness to reduce non-filtrable residue (suspended solids) loadings to Sheep Creek. During a high runoff period the ponds discharges exceeded the emission standards for non-filtrable residue as set out in Water Licences 73-WP-071 and 73-WP-010. The emission standard in the above Licences for iron was only exceeded once on the No. 9 mine pond discharge. All other iron values were below acceptable limits. The No. 9 mine pond showed a reduction in non-filtrable residue ranging from 46% to 73%, however, the discharge concentrations were above the acceptable limits. The No. 9 mine area contributes to the non-filtrable residue loading in Sheep Creek. The settling ponds can effectively remove non-filtrable residue in light runoff conditions, however, as runoff increases the ponds lose their effectiveness in removal.

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BANK =     39              - QL SYSTEMS LIMITED -        D=  29741  CEN

35339          UPDATE NO.: CENV(A)
TREATMENT OF ACID MINE WASTEWATER AT FALCONBRIDGE'S HARDY CROWN
PILLAR PROJECT
OKO UM, TAYLOR WLR
AFFILIATION: ACRES CONSULTING SERVICES LIMITED, TORONTO, ONTARIO
CANADIAN MINING AND METALLURGICAL BULLETIN CMMB-A
1974-04 067 744 43-49
PUBLICATION TYPE: 1 Article
REF. SOURCE: 0010501
KEYWORDS: ENVIRONMENTAL CONTROL, ACID WASTEWATER, DEWATERING,
HARDY MINES, DISSOLVED IRON, WASTEWATER TREATMENT, WATERCOURSES,
FALCONBRIDGE HARDY MINE, WATER QUALITY, DEWATERING WELLS, WATER
TREATMENT PLANT
     THIS PAPER DISCUSSES THE DEWATERING OF THE OVERBURDEN
COVERING THE OREBODY AT FALCONBRIDGE'S HARDY MINE, AND THE
UNIQUE ENVIRONMENTAL CONTROL PROBLEMS ENCOUNTERED DUE TO THE
LARGE QUANTITIES OF DISSOLVED IRON AND HIGH ACIDITY OF THE
AQUIFER.  2 REF, 2 TAB, 4 FIG.

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BANK =     40              - QL SYSTEMS LIMITED -        D=    581  CEN

1390           UPDATE NO.: CENV(A)
SULFIDE TO SULPHATE REACTION MECHANISM
OHIO STATE UNIVERSITY
WATER POLLUTION CONTROL RESEARCH
U.S. GOVT PRINTING OFFICE  WASHINGTON, DC
1970 71, + SAPP
PUBLICATION TYPE: 3 Report
REF. SOURCE: WATER SECTOR II
FEDERAL WATER POLLUTION CONTROL ADMINISTRATION, DEPT OF THE
INTERIOR
KEYWORDS: MINE DRAINAGE, ACID MINE WATER, COAL MINE DRAINAGE,

SULFIDES, IRON SULFIDES, PYRITE, FERROBACILLUS, POLLUTION
ABATEMENT, INDUSTRIAL WASTES, REACTION KINETICS
    SULFURIC ACID MINE WATER PRODUCTION FROM OXIDIZED PYRITE WAS
STUDIED IN DETAIL.  THE MINERALOGICAL FEATURES OF PYRITE, THE
RATE-LIMITING REACTIONS, AND VARIABLES AFFECTING THE RATE OF
THESE REACTIONS WERE IDENTIFIED.  ONE OXIDATION MODE IS THE
DIRECT OXIDATION BY OXYGEN, ANOTHER IS OXIDATION BY FERRIC IONS,
SO SUCH A KNOWLEDGE OF THE FERRIC-FERROUS RATIO, THE DISSOLVED
OXYGEN, TOTAL IRON CONTENT AT THE REACTION SITE, THE REACTION
REGIME WAS DETERMINED.  KINETIC EQUATIONS WERE DERIVED FOR BOTH
REACTION MODES AND COULD PREDICT THE OXIDATION RATE.  FOR THE
FIRST MODE THE RATE DEPENDED ONLY ON DISSOLVED OXYGEN, FOR THE
SECOND ONLY THE FERRIC-FERROUS RATIO AND FREE FERRIC ION
CONCENTRATION.  IN A REAL SYSTEM THE FERRIC-FERROUS RATIO IS
DETERMINED BY MICROBIAL ACTIVITY, BUT THIS IS LIMITED BY PH,
OXYGEN CONCENTRATION AND NUTRIENT LEVELS.
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RANK = 41 - QL SYSTEMS LIMITED - D= 516 CEN

1186 UPDATE NO.: CENV(A)
SULFIDE TO SULPHATE REACTION MECHANISM, WATER POLLUTION CONTROL
RESEARCH SERIES
FEDERAL WATER POLLUTION CONTROL ADMINISTRATION
U.S. GOVERNMENT PRINTING OFFICE WASHINGTON, DC
1970 115
PUBLICATION TYPE: 3 Report
REF. SOURCE: WATER SECTOR LI
KEYWORDS: COAL MINE DRAINAGE, MINE DRAINAGE, SULFIDES, IRON
SULFIDES, PYRITE, FERROBACILLUS, REACTION KINETICS, MINERALOGY,
OXYGENATION, MICROBIOLOGY, OXIDATION

OXIDIZED PYRITE CONTRIBUTES SULPHURIC ACID TO MINE DRAINAGE. KINETICS OF THIS OXIDATION REACTION WERE STUDIED. BOTH OXYGEN AND FERRIC ION ARE OXIDANTS AND THE TWO HAVE INDEPENDANT OXIDATION RATES WHEN STUDIED SEPARATELY. IN A REAL SYSTEM THE FERRIC/FERROUS RATIO IS DETERMINED BY A RELATIVE MICROBIAL ACTIVITY, I.E. THE NUMBER OF BACTERIA PER EXPOSED PYRITE SURFACE. BACTERIA CONCENTRATION IS LIMITED BY PH AND OXYGEN CONCENTRATION AS WELL AS NUTRIENT LEVELS.

RANK = 42 - QL SYSTEMS LIMITED - D= 42081 CEN

47786 UPDATE NO.: CENV81(4)
Fibrous minerals in the Wabush Iron Ore district, Labrador,
Newfoundland, Canada

MANTTILA FK
AFFILIATION: McMaster Univ, Hamilton, Ont
Environ Geochem Rep No 1980/2
Dep Geol, McMaster Univ, Hamilton, Ont
1980-03 126p 1 app. 51 ref LANG.: En
PUBLICATION TYPE: 6 Thesis
REF. SOURCE: 0010104
GEOGRAPHIC ID.: W66 57,N52 55
KEYWORDS: Wabush Iron Ore District, Labrador, Newfoundland,
mineralogy, fibrous minerals, geology, crystallography,
carbonates, chemical properties, iron, water analysis, water
chemistry, tailings, rock bottom sediments, soil sampling, mine
wastes, weathering, metals, amphiboles, lakes, X-ray diffraction

Fibrous minerals are common in the highgrade, metamorphic, Precambrian Wabush Iron Formation, Labrador, Newfoundland, Canada. The most abundant fibres are amphiboles of the cummingtonite-grunerite series; mineralogical studies support the work of Klein (1960, 1964, 1966) and Chakraborty (1966). Iron ore mining and pelleting operations in the Labrador City area yield tailings containing many fibres (amphibole; iron and iron-manganese compounds) which find their way into the natural waterways. Water samples in Wabush Lake have fibre concentrations greater than 2 x 10 exp 9 per litre. Analysis of concentration and/or chemical composition of water, tailings, rock, bottom sediment, and soil samples identifies mine waste deposits as the major source of fibres. Comparisons between sediment inputs (and inputs of mineral fibres) from mining operations and natural weathering processes indicate the major impact of mine wastes. Calculations applying Stokes' Law of Settling to the fibrous minerals illustrate how the fibres settle out in Wabush Lake.

BASE = 43 - QL SYSTEMS LIMITED - D= 29737 CEB

35335 UPDATE NO.: CEBV(A)
ACID DRAINAGE CONTROL AND WATER TREATMENT AT HEATH STEELE
ROSSE E
AFFILIATION: AMAX LEAD AND ZINC INC, NEWCASTLE, N.B.
CANADIAN MINING AND METALLURGICAL BULLETIN CMMB-A
1974-11 067 751 54-61
PUBLICATION TYPE: 1 Article
REF. SOURCE: 0010501
KEYWORDS: ENVIRONMENTAL CONTROL, WATER TREATMENT, ACID DRAINAGE,
HEATH STEELE MINES, DRAINAGE CONTROL, TAILINGS DISPOSAL, SALMON
MIGRATION, NEW BRUNSWICK, STREAM WATER QUALITY, WATER
CONTAMINATION, MILL TAILINGS

HEATH STEELE MINES LIMITED IS LOCATED IN NEW BRUNSWICK,
OPERATES A 3,000 TPD MINE AND CONCENTRATOR, AND PRODUCES LEAD,
ZINC AND COPPER FLOTATION CONCENTRATES FROM COMPLEX MASSIVE
SULPHIDE ORES. THE PROBLEM OF ACID DRAINAGE IS CAUSED BY

UNDERGROUND AND SURFACE WATER CONTACTING METAL SULPHIDES,
BECOMING ACID AND ACQUIRING DISSOLVED HEAVY METALS. IN
SUFFICIENT CONCENTRATIONS, THESE METALS ARE TOXIC TO FISH LIFE.
BECAUSE ALL WATER FROM THE PROPERTY EVENTUALLY DRAINS INTO THE
NORTHWEST MIRAMICHI RIVER, IT HAS A DETRIMENTAL EFFECT ON THE
SALMON MIGRATION IN THAT STREAM. BY THE END OF 1969, GOVERNMENT
AGENCIES HAD DEVELOPED STREAM WATER QUALITY REQUIREMENTS FOR THE
MINE. TO MEET THESE REQUIREMENTS, A COMPREHENSIVE WATER
POLLUTION ABATEMENT PROGRAM WAS STARTED EARLY IN 1970 AND BECAME
FULLY OPERATIONAL BY THE FALL OF 1972. AREAS WITH CONTAMINATED
SURFACE DRAINAGE WERE IDENTIFIED AND ISOLATED. CAPITAL COST OF
THE PROJECT AMOUNTED TO $2,500,000. CURRENT ANNUAL OPERATING
COSTS ARE $220,000, OR 20 CENTS PER TON OF ORE. THE PROGRAM HAS
SUBSTANTIALLY IMPROVED THE WATER QUALITY IN THE AFFECTED
STREAMS. AVERAGE METAL TOXICITY IN THE NORTHWEST MIRAMICHI
RIVER HAS BEEN REDUCED BY 83% AND PEAKS HAVE BEEN REDUCED BY
92%. MOST IMPORTANT OF ALL, SALMON MIGRATION HAS NOTICEABLY
INCREASED DURING THE PAST 2 YEARS. 5 FIG, 5 TAB.

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BASE = 44 - QL SYSTEMS LIMITED - D= 13193 CEB

17083 UPDATE NO.: CEBV(A)
UTILIZATION OF INDUSTRIAL WASTES AND WASTE BY-PRODUCTS FOR
PHOSPHORUS REMOVAL: AN INVENTORY AND ASSESSMENT
FOWLIE PJA, SHANNON EE
AFFILIATION: ENVIRONMENTAL PROTECTION SERVICE, ENVIRONMENT
CANADA, OTTAWA, ONTARIO
RESEARCH REPORT 6
ENVIRONMENT CANADA, ENVIRONMENTAL PROTECTION SERVICE OTTAWA ONT
1973-06 87 P
PUBLICATION TYPE: 3 Report
REF. SOURCE: 0010901 REF. SOURCE NO.: 17083
KEYWORDS: WASTE TREATMENT, INDUSTRIAL WASTES, PHOSPHORUS,
LABORATORY TESTS, WASTE WATER, PICKLE LIQUOR, BIOCHEMICAL OXYGEN
DEMAND, PILOT PLANTS, HEAVY METALS, TESTING PROCEDURES,
ANALYTICAL TECHNIQUES, ACTIVATED SLUDGE, FERRIC SULFATE, METAL
TRANSPORT, JAR TESTS EFFLUENTS

THIS STUDY PRESENTS THE RESULTS OF AN INVENTORY OF THE WASTE
PRODUCTS PRODUCED BY 141 COMPANIES IN ONTARIO AND QUEBEC. WASTE
MATERIAL FROM 48 OF THESE COMPANIES WAS EVALUATED FOR PHOSPHORUS
REMOVAL EFFICIENCY IN JAR TESTS. SEVERAL WASTES WERE FOUND TO
REMOVE PHOSPHORUS TO SOME DEGREE—PICKLE LIQUORS, FERRIC
SULFATE, MILL SCALE, MINE ACID, CARBIDE LIME, AND OTHERS.
PICKLE LIQUORS CONSISTENTLY GAVE EFFLUENT PHOSPHORUS LEVELS LESS
THAN 1 MG/L AND DID NOT AFFECT COD REMOVAL OR EFFLUENT PH.
FERRIC SULFATE ALSO GAVE EFFLUENT PHOSPHORUS LEVELS LESS THAN 1
MG/L AND HEAVY METALS WERE ACCUMULATED IN THE SLUDGE. FULL-SCALE
PHOSPHORUS REMOVAL STUDIES AT A WASTE WATER TREATMENT
PLANT USING PICKLE LIQUORS SHOWED THAT ALL HEAVY METALS EXCEPT
IRON ACCUMULATED IN THE LIQUOR AND IN THE SLUDGE SOLIDS. PICKLE

LIQUORS, FERRIC SULFATE, AND CARBIDE LIMES APPEAR TO BE
EFFECTIVE PHOSPHORUS REMOVAL AGENTS. ANALYTICAL PROCEDURES AND
EXPERIMENTAL RESULTS ARE GIVEN. 22 REF 24 FIG 15 TABLES

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BANK = 45 - QL SYSTEMS LIMITED - D= 52067 CEW

57777 UPDATE NO.: CEWV82(5)
Recently developed blasting techniques in frozen iron ore at Schefferville, Quebec
GARG OP
AFFILIATION: Iron Ore Co of Canada, PO Box 1000, Schefferville, Que G0G 2T0
ED.: NRCSB SJE
Proceedings of a Workshop on Permafrost Engineering, Ottawa, Ont, Sept. 27-28, 1979
Tech Mem no 130
Natl Res Counc Can, Assoc Comm Geotech Res, Ottawa, Ont
1980-12 25-30 LANG.: En
PUBLICATION TYPE: 8 Abstract SCI.: OON
REF. SOURCE: 0040102 REF. SOURCE NO.: TA701N28t2 no.130 Bldg.
GEOGRAPHIC ID.: N66 50,W54 48
KEYWORDS: Schefferville, Quebec, blasting technique, frozen iron ore, waste materials, mining operations, drilling, frozen grounds

Since 1957, the Iron Ore Company of Canada has been involved in blasting frozen ore and waste material in connection with its open pit mining operations located in Northern Quebec and Labrador. The two main problems encountered during the drilling and blasting operations were: 1) caving of holes due to melting of ice; 2) poor fragmentation even if the holes were loaded with more expensive Hydromex type of slurry explosives as compared to AN/Fuel Oil Mixture. Based on several studies carried out by the mine personnel since 1972, the following improvements have been made in the drilling and blasting phase of the mining operation: delineation of frozen ground in the Schefferille area which lies in the discontinuous permafrost zone helps in planning the drilling and blasting operations; a systematic program to determine the physico-mechanical properties of frozen rocks is being carried out; loading of explosives in holes as soon as these are drilled; water from the hole bottom is pumped out using a portable pump; drilling and loading of frost holes during winter; use of double wall liners in drill holes; by reducing the size of blasts in frozen material, the possibility of refreezing of blasted material is significantly reduced; as much as possible, the dirt stripping is removed during the September to November period when the ground is thawed to maximum depth; mapping of ground ice in active mining faces and in drill holes helps in estimating the quantity and type of ice likely to be encountered during blasting. Additional studies are currently being undertaken.

50498 UPDATE NO.: CENV81(6)
Granduc environmental baseline sampling
BC Research
BC Res, 3650 Wesbrook Mall, Vancouver, BC V6S 2L2
1980-02 75p 15 fig. 13 tab. 4 app. 3 ref LANG.: En
PUBLICATION TYPE: 3 Report
REF. SOURCE: 0011481
NOTES: Report prepared for Esso Minerals Canada
GEOGRAPHIC ID.: W130 05,N56 15
KEYWORDS: British Columbia, Bowser River, Leduc River, Granduc Mines, copper mining, water quality, heavy metals, water chemistry, zinc, lead, chromium, arsenic, cadmium, sulphates, water turbidity

This report contains the results of field studies to determine the background levels of heavy metals in the Leduc River Bowser River, the levels of heavy metals in the sediments of rivers and lakes of the river systems, the pre-operational concentrations of heavy metals in the sediments, and the sinks for tailings from the previous operations of the Granduc Mine. These results have been carried out to determine water and sediment characteristics prior to the proposed re-opening of the Granduc Mine in 1980. Copper concentrations in bottom sediments from Bowser Lake and the Bowser River upstream of the lake indicate that the tailings from previous mining operations have remained in the upper reaches of the river. There was no evidence that appreciable amounts of tailings have reached the upstream end of Bowser Lake. Concentrations of arsenic, lead, and zinc at a location on the Upper Bowser River varied considerably over the three sample periods. Sediments from the Leduc River near the mine portal contained variable but consistently enriched levels of copper compared with downstream Bowser River sediments. Concentrations of dissolved metals, except for iron and zinc, were low on all sampling occasions. Arsenic, cadmium, and chromium were usually less than .1 ppm. Copper and lead concentrations were generally at or below 3 ppm. Metal concentrations in mine drainage water samples were less than the most stringent level cited in the B.C. Pollution Control Objectives for the mining, smelting, and related industries. Water in the river systems was principally from snowmelt and was soft throughout the area examined. Sulphate values were high for soft water streams. River waters throughout the area were very turbid.

RANK = 47 - QL SYSTEMS LIMITED - D= 53890 CEB

59600 UPDATE NO.: CENV82(7)
Heavy metal release from mine tailings into sea water - a laboratory study
HOFF JT, THOMPSON JAJ, WONG CS
AFFILIATION: Ocean Chem Div, Inst Ocean Sci, PO Box 6000, Sidney, BC V8L 4B2
Mar Pollut Bull MPNBAZ
ISSN 0025-326X
1982-08 13(8) 283-286 3 fig, 2 tab, 17 ref LANG.: En
PUBLICATION TYPE: 1 Article
REF. SOURCE: 0010501
NOTES: Funded by the Natl Res Counc Can
KEYWORDS: British Columbia, seawater, mine wastes, heavy metals, experimental data, iron, copper, lead, manganese, nickel, cadmium, zinc, waste disposal, ion exchange, dissoved metals, electrochemical reactions, leaching

In a laboratory experiment to simulate mine tailings disposal into a coastal inlet of British Columbia, initial rapid increases in dissolved iron, copper and lead were observed in the first three hours with subsequent slow decreases to background values within one month. Manganese and nickel increased slowly during the experiment while cadmium and zinc did not increase.

RANK = 48 - QL SYSTEMS LIMITED - D= 40842 CEB

46547 UPDATE NO.: CENV81(3)
Distribution and transport of heavy metals in the sediments of a small northern eutrophic lake
MOORE JW
AFFILIATION: Alta Environ Cent, Bag 4000, Vegreville, Alta T0B 4L0
Bull Environ Contam Toxic BECTA6
ISSN 0007-4861
1980-06 24(6) 828-833 15 ref, 3 tab LANG.: En
PUBLICATION TYPE: 1 Article
REF. SOURCE: 0010501
KEYWORDS: Thompson Lake, Northwest Territories, heavy metals, tailings, sediments, eutrophic lake, heavy metal transport, water movement, waste discharges

Transport of heavy metals, and their subsequent sorption by sediments in freshwaters, depends on many factors including the reactive organic and sulphide ion content of the sediments, water movements and metal solubility. Such factors are often the cause of large scale dispersal of metals through lakes and rivers and are therefore indirectly responsible for introducing pollutants into the food chain. Despite the fact that heavy metal transport is an important aspect of waste disposal schemes and aquatic resource utilization, there is little information on the long term fate of these pollutants in small enclosed ecosystems. The purpose of this study was therefore to measure the concentrations of heavy metals in the sediments of a small, eutrophic lake, which received waste discharges from a gold mine between 1941 and 1949. The data were then used to measure relative rates of movement which were in turn correlated with variations in environmental conditions.

RANK = 49 - QL SYSTEMS LIMITED - D= 18360 CEN

23280 UPDATE NO.: CENV(A)
ACID MINE DRAINAGE ABATEMENT
HAWLEY JR
AFFILIATION: INDUSTRIAL WASTES, ONTARIO MINISTRY OF THE ENVIRONMENT
CANADIAN MINING JOURNAL CAMJ-A
GARDENVALE, P.Q.
1974-06 095 C06 38P
PUBLICATION TYPE: 1 Article
REF. SOURCE: 0010501
KEYWORDS: ACID MINE DRAINAGE, ONTARIO, TAILINGS, WASTES, WASTE DISPOSAL, ENVIRONMENT, POLLUTION, MINING INDUSTRY, TAILING DAMS, PERMEABLE, IMPERMEABLE, SEEPAGE, IRON SULPHIDE, CHEMICAL TREATMENT, LIME TREATMENT, SULPHUR-OXIDATION PONDS, OXIDATION

THE PROBLEM OF ACID MINE DRAINAGE IN ONTARIO IS LARGELY UNDER CONTROL BECAUSE OF THE COOPERATION OF THE MINING INDUSTRY. DISPOSAL OF TAILINGS INTO LAKES IS AVOIDED, AND ATTEMPTS ARE MADE TO MAKE THE TAILINGS DAMS IMPERMEABLE TO AVOID SEEPAGE. THERE IS SOME ATTEMPT TO RECOVER THE IRON SULPHIDE MINERALS, WHILE THE RE-USE OF WASTE WATER REDUCES THE VOLUME OF THE DISCHARGE. THE CHEMICAL TREATMENT OF ACID MINE DRAINAGE IS, AT BEST, A SHORT TERM SOLUTION. NATURAL OXIDATION IS THE ONLY RELATIVELY SUCCESSFUL METHOD, AND MECHANICAL AERATION COULD REDUCE THE RETENTION TIME.

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RANK = 50 - QL SYSTEMS LIMITED - D= 18342 CEN

23261 UPDATE NO.: CENV(A)
FOCUS ACID POLLUTES
ASTON WM
AFFILIATION: NEWS SERVICE, WEST VIRGINIA UNIVERSITY
CANADIAN MINING JOURNAL CAMJ-A

GARDENVALE, P.Q.
1974-03 095 C03 59-61
REF. SOURCE: 0010501
KEYWORDS: MINING, MINING INDUSTRY, COAL, BASE METALS, WEST VIRGINIA, APPALACHIA, IRON PYRITE, POLLUTION, SULPHURIC ACID, FERRIC HYDROXIDE, WATER POLLUTION, YELLOWBOY, ACID MINE DRAINAGE, THIOBACILLUS, FERROBACILLUS, PH, TREATMENT, COSTS, NEUTRALIZATION, REVERSE OSMOSIS, THIOOXIDANS, FERROOXIDANS

THIS ARTICLE EXPLAINS THE CAUSES OF ACID MINE DRAINAGE. IT DISCUSSES THE SCOPE OF THE PROBLEM AND DESCRIBES RESEARCH IN PROGRESS TO DEAL WITH IT. WHEN IRON PYRITE COMES IN CONTACT WITH AIR AND WATER IT FORMS FERRIC HYDROXIDE AND SULPHURIC ACID BUT THIS PROCESS CAN BE SLOWED DOWN BY MAKING LESS AIR AND WATER AVAILABLE FOR THE PURPOSE. THE ACIDS CAN BE NEUTRALIZED BUT THAT STILL LEAVES THE PROBLEM OF DISPOSING OF THE TREATED WATERS. THE USE OF BACTERIA AND ALGAE IS UNDER RESEARCH TO REDUCE THE EFFECTS OF ACID DRAINAGE OR TO MAKE USE OF THAT WATER AND ITS PRODUCTS. 3 FIGURES

* * *

RANK = 51 - QL SYSTEMS LIMITED - D= 11578 CEN

15272 UPDATE NO.: CENV(A)
FILTERABILITY OF LIME-IRON SLUDGES GENERATED IN THE CHEMICAL
PRECIPITATION OF PHOSPHORUS FROM TREATED SEWAGE
SCOTT GW, CORNWALL GE
AFFILIATION: CIVIL ENGRG DEPT, UNIV WATERLOO, WATERLOO, ONT
PROCEEDINGS SIXTH CDN SYMPOSIUM WATER POLLUTION RESEARCH
UNIV TORONTO, INST ENVIRONMENTAL SCIENCES AND ENGRG TORONTO ONT
1971-02 006 160-177
PUBLICATION TYPE: 5 Proceedings
REF. SOURCE: 0010104 REF. SOURCE NO.: 15263
DEPT ENERGY, MINES AND RESOURCES
KEYWORDS: INVESTIGATIONS, SLUDGE, LIME-IRON SLUDGE, CHEMICAL
PRECIPITATION, PHOSPHORUS, TREATMENT, SEWAGE TREATMENT,
FILTRATION, FILTERABILITY, SEPARATION TECHNIQUES, EQUIPMENT,
CHEMICALS, DISPOSAL, SLUDGE DISPOSAL

CONSIDERATION OF SLUDGE DISPOSAL IS AN IMPORTANT ASPECT IN THE RATIONAL SELECTION OF THE MOST APPROPRIATE PHOSPHOROUS REMOVAL TECHNIQUE. THE DEWATERING OF LIME-IRON SLUDGES (GENERATED BY DOSING THE CHEMICALS TO BIOLOGICALLY TREATED MUNICIPAL WASTEWATER) WAS STUDIED BY MEANS OF THE BUCHNER FUNNEL AND THE FILTER LEAF APPARATUS. THE RESULTS INDICATE THAT THE SLUDGES DEWATER MORE EFFECTIVELY THAN CONVENTIONAL BIOLOGICAL SLUDGES WITH CONDITIONING. ALTHOUGH THE SLUDGE DEWATERS WELL, IT DISPLAYS LOWER FILTER YIELDS THAN WOULD BE EXPECTED BECAUSE OF AN INABILITY TO FORM A THICK CAKE DURING THE PICK-UP PORTION OF THE CYCLE. A NUMBER OF TECHNIQUES EXIST FOR INCREASING THE FILTER YIELD OF THESE SLUDGES. 8 REF., 6 TABLES, 2 FIG.

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RANK = 52 - QL SYSTEMS LIMITED - D= 395 CEN

969 UPDATE NO.: CENV(A)
TREATMENT OF ACID MINE DRAINAGE, WATER POLLUTION CONTROL
RESEARCH SERIES
BIKERMAN JJ, RANSCH FJ, ROSE SW
U.S. GOVT PRINTING OFFICE WASHINGTON, DC
1970 EE
PUBLICATION TYPE: 3 Report
REF. SOURCE: WATER SECTOR II
KEYWORDS: ACID COAL MINE DRAINAGE, FOAM TOWER, FOAM SEPARATION,
BATCH TREATMENT PLANTS, METAL ION REMOVAL, CHEMICAL COSTS, IRON,
PLANT DESIGN, CALCIUM, FEASIBILITY STUDY, MANGANESE, MAGNESIUM,
SURFACTANT, TREATMENT COSTS, WATER PURIFICATION, LIME
NEUTRALIZED DRAINAGE, OPERATING COSTS, CAPITAL COSTS

BASIC EXPERIMENTS WERE CONDUCTED TO ESTABLISH THE FEASIBILITY OF FOAM FRACTIONATION IN THE TREATMENT OF ACID COAL MINE DRAINAGE FOR REMOVAL OF THE METAL IONS IRON, CALCIUM, MANGANESE AND MAGNESIUM. THE INDEPENDENT VARIABLES CONTROLLING CONCENTRATION RATIO OF SURFACTANT TO IRON, AIR VOLUME THROUGHOUT, FOAM DRAINAGE TIME, TOTAL DISSOLVED SALT CONTENT AND TYPE OF SURFACTANT USED. THE MAJOR PART OF IRON, CALCIUM, MANGANESE AND MAGNESIUM CAN BE FOAM SEPARATED FROM ACID SOLUTION. FOAM SEPARATION WAS TESTED ON PARTIALLY LIME NEUTRALIZED, AND COMPLETELY LIMESTONE NEUTRALIZED ACID MINE DRAINAGE. OPERATING AND CAPITAL COSTS ARE ESTIMATED FOR 0.1 AND 1.0 MGD BATCH TREATMENT PLANTS. THERE ARE NINETEEN TITLES IN THE BIBLIOGRAPHY, ELEVEN TABLES, FIFTY-EIGHT EXPERIMENT TABLES AND FIGURES.

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BANK =     53             - QL SYSTEMS LIMITED -        D= 29343  CEN

34935           UPDATE NO.: CENV(A)
THE BIOGEOCHEMISTRY OF HEAVY METALS IN POLLUTED LAKES AND
STREAMS AT FLIN FLON, CANADA, AND A PROPOSED METHOD FOR LIMITING
HEAVY-METAL POLLUTION OF NATURAL WATERS
JACKSON TA
AFFILIATION: FRESHWATER INST, WINNIPEG, MANITOBA
ENVIRONMENTAL GEOLOGY
SPRINGER-VERLAG NEW YORK, NY
1978 002 003 173-189
PUBLICATION TYPE: 1 Article
REF. SOURCE: 0010501
KEYWORDS: HEAVY METALS, POLLUTION, FILTERED WATER, PH,
CONDUCTIVITY, PARTICULATES, PLANKTON, MUD, CORRELATION, ANIONS,
FLIN FLON, MANITOBA
    THE BIOGEOCHEMISTRY OF ZN, CD, CU, HG AND PB IN LAKES AND
STREAMS POLLUTED BY MINE AND SMELTER WASTES EMITTED AT FLIN
FLON, CANADA, WAS INVESTIGATED.  IN SCHIST LAKE, A REPOSITORY

FOR BOTH TAILINGS POND DRAINAGE AND SEWAGE, GREEN ALGAL BLOOMS
GENERATED BY NUTRIENTS FROM SEWAGE PROMOTE ENTRAPMENT OF METALS
IN SEDIMENTS BY (1) ACCUMULATION OF METALS FROM SOLUTION BY
ALGAL SESTON, WITH PREFERENTIAL UPTAKE OF ZN, THE MOST ABUNDANT
METAL, FOLLOWED BY SINKING OF THE SESTON; AND (2) PRODUCTION OF
H2S DURING DECOMPOSITION OF DEAD ALGAE, RESULTING IN SULFIDE
PRECIPITATION.  METALS ARE PARTIALLY RESOLUBILIZED FROM SESTON
AS IT DECOMPOSES WHILE SINKING.  PREFERENTIAL RETENTION OF CU BY
SINKING SESTON AND BY MUD PROMOTES CU ENRICHMENT IN THE MUD BUT
THE CU / ZN RATIO OF MUD VARIES WITH THE CU / ZN RATIO OF
SURFACE WATER SESTON.  IN BOTTOM MUDS, PARTITIONING OF A METAL
BETWEEN SULFIDE AND ORGANIC MATTER IS STRONGLY DEPENDENT ON THE
STABILITY OF THE METAL SULFIDE AS MEASURED BY ITS STANDARD
ENTROPY, THE PROPORTION OF SULFIDE BOUND METAL DECREASING IN THE
ORDER HG GREATER THAN CD GREATER THAN CU GREATER THAN PB GREATER
THAN ZN.  WHEN SULFIDE RICH MUDS WERE HEATED UNDER HELIUM, X-RAY
DIFFRACTION REVEALED ABUNDANT WELL CRYSTALLIZED TRACES OF THE
MINERAL WERE DETECTED IN UNHEATED MUD, HOWEVER.  CU SULFIDE
FAILED TO CRYSTALLIZE, SUGGESTING INTERFERENCE BY SORBED
IMPURITIES. METALS WERE CONCENTRATED IN H2S RICH MUDS AND
EXTRACTION OF MUDS WITH VARIOUS SOLVENTS AND BY ELECTRODIALYSIS
SHOWED THAT SULFIDE WAS MUCH MORE EFFECTIVE THAN ORGANIC MATTER
IN SUPPRESSING REMOBILIZATION OF METALS. THESE RESULTS INDICATE
THAT INTRODUCTION OF SEWAGE TOGETHER WITH HEAVY-METAL EFFLUENTS
INTO SETTLING PONDS COULD BE AN EFFECTIVE AND ECONOMIC METHOD
FOR LIMITING HEAVY METAL POLLUTION OF NATURAL WATERS. 71 REF.,
14 FIG., 6 TAB.

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19529          UPDATE NO.: CENV(A)
INDUSTRIAL WATER RESOURCES OF CANADA, WATER SURVEY REPORT NO 4
COLUMBIA RIVER DRAINAGE BASIN IN CANADA 1949-50
THOMAS JFJ
AFFILIATION: INDUSTRIAL MINERALS DIVISION MINES BRANCH CANADA
DEPARTMENT OF MINES
INDUSTRIAL WATER RESOURCES OF CANADA
INDUSTRIAL MINERALS DIVISION MINES BRANCH CANADA DEPARTMENT OF
MINES  OTTAWA ONTARIO  PUBLISHER NO.: 838
1953 80 P
PUBLICATION TYPE: 3 Report
REF. SOURCE: C011001
FEDERAL GOVERNMENT OTTAWA
KEYWORDS: WATER QUALITY, WATER CHEMISTRY, WATER ANALYSIS, WATER
TREATMENT, INDUSTRIAL WATER, DOMESTIC WATER, SURFACE WATERS,
WATER WORKS, BASELINE STUDIES, PLANNING, IRRIGATION, KOOTENAY
RIVER, WATER SUPPLY, CHLORINATION, WATER RESOURCES, WATER
RESOURCES DEVELOPMENT, COLUMBIA RIVER BASIN, MINERAL CONTENT
    THE REPORT PRESENTS THE DETAILED RESULTS OF STUDIES TO
DETERMINE THE CHEMICAL CHARACTER OF SURFACE AND MUNICIPAL WATER

SUPPLIES AVAILABLE FOR INDUSTRIAL AND DOMESTIC USE IN THE
COLUMBIA RIVER BASIN IN CANADA.  MONTHLY SAMPLES WERE TAKEN FOR
THE PERIOD FEBRUARY 1949 TO FEBRUARY 1950 FROM 73 STATIONS
COVERING MOST MAJOR SURFACE SUPPLIES.  TESTS CARRIED OUT IN THE
B.C. LABORATORY WERE REPEATED ON THE SAMPLES IN OTTAWA.  VALUES
IN BOTH LABORATORIES COMPARED WELL.  THE OTTAWA LAB REPORTED
HIGHER VALUES FOR CALCIUM, NITRATE, SILICA AND FLUORIDE.  VALUES
ARE GIVEN FOR THE FOLLOWING CONSTITUENTS:  PH, COLOUR,
TURBIDITY, SPECIFIC CONDUCTANCE, DISSOLVED OXYGEN, CARBON
DIOXIDE, SUSPENDED MATTER, RESIDUE ON EVAPORATION, CALCIUM,
MAGNESIUM, SODIUM POTASSIUM, IRON, SULPHATE, CHLORIDE, NITRATE,
FLUORIDE, BORON, BICARBONATE, CARBONATE, SILICA AND HARDNESS.
THE RESULTS OF THE CANADIAN TESTS SHOWED SATISFACTORY AGREEMENT
WITH SIMILAR TESTS CONDUCTED IN THE COLUMBIA BASIN IN THE U.S.
TABLES SHOW THE COMPARISON OF ANALYTICAL DATA BETWEEN THE U.S.
AND CANADIAN LABORATORIES.  RELATIONSHIPS BETWEEN MINERAL
CONTENT AND RIVER FLOW IS GIVEN FOR THE KOOTENAY AND COLUMBIA
RIVERS.  NONE OF THE WATERS STUDIED WERE FOUND UNSUITABLE FOR
IRRIGATION ON THE BASIS OF SODIUM OR BORON CONTENT.  SURFACE
WATERS ARE MOSTLY MEDIUM-HARD AND BICARBONATE IN CHARACTER.
SUITABLE WATER IS AVAILABLE FOR MOST INDUSTRIES WITHOUT
EXTENSIVE TREATMENT, THE MAIN PROBLEM BEING THE REMOVAL OF
TURBIDITY AND EXCESSIVE CARBONATE HARDNESS.  DATA IS GIVEN ON
MUNICIPAL WATER WORKS FOR CAPACITY, SOURCE, TREATMENT AND
CONSUMPTION. ECONOMIC CONSIDERATIONS FOR POTENTIAL WATER USE ARE
BRIEFLY DISCUSSED.  6 TABLES 7 FIG 2 APP 1 MAP.  BC020000,
BC030000.  THIS DOCUMENT IS AVAILABLE FROM THE UNIVERSITY OF
BRITISH COLUMBIA, MAIN LIBRARY - CALL NO. TD226 A1 C25.

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RANK = 55 - CL SYSTEMS LIMITED - D= 358 CPB

919 UPDATE NO.: CENV(A)
TREATMENT OF ACID MINE DRAINAGE BY OZONE OXIDATION, WATER POLLUTION RESEARCH SERIES
BROOKHAVEN NATIONAL LABORATORY, ASSOCIATED UNIVERSITIES INCORPORATED
U.S. GOVT PRINTING OFFICE WASHINGTON, DC
1970 87
PUBLICATION TYPE: 3 Report
REF. SOURCE: WATER SECTOR LI
KEYWORDS: ENGINEERING, NEUTRALIZATION, SLURRIES, ECONOMIC FEASIBILITY, TREATMENT, SETTLING BASINS, RESEARCH AND DEVELOPMENT, FLOW METER, OZONE, AERATION, PHOTOMETRY, MINE DRAINAGE, SEPARATION TECHNIQUES, GAS CHROMATOGRAPH, SLUDGE DISPOSAL, WATER TREATMENT SPECTROMETERS, OXIDATION, CHEMICAL PRECIPITATION

AN ENGINEERING DESIGN AND ECONOMIC STUDY TO EVALUATE THE FEASIBILITY OF USING OZONE FOR TREATMENT OF ACID MINE DRAINAGE WAS PERFORMED. THE TREATMENT CONSISTS OF RAPID OXIDATION OF FERROUS TO FERRIC IRON WITH OZONE AND NEUTRALIZATION WITH LIMESTONE. OZONE PRODUCTION IS CONSIDERED USING ELECTRICAL DISCHARGE, ISOTOPIC RADIATION AND DISTRIBUTION SYSTEM IS FOUND TO BE MOST ECONOMICAL, FOLLOWED BY ELECTRIC DISCHARGE CENTRAL AND ONSITE PLANTS. THE STUDY CONCLUDES THAT AN OZONE PROCESS IS FEASIBLE, COMPARES ECONOMICALLY WITH EXISTING PROCESSES AND OFFERS POTENTIAL ADVANTAGES IN PROCESS CONTROL REDUCED NEUTRALIZATION COSTS, AND SIMPLIFIED ACID MINE DRAINAGE SLUDGE HANDLING AND DISPOSAL. A NUMBER OF FIGURES AND TABLES ARE INCLUDED IN THE REPORT.

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34620 UPDATE NO.: CENV(A)
TREATMENT OF BASE METAL MINE DRAINAGE AT PILOT SCALE
HUCK PM, LECLAIR BP
TECHNOLOGY DEVELOPMENT REPORT
FISHERIES AND ENVIRONMENT CANADA, EPS, OTTAWA, ONT
PUBLISHED NO.: EPS-4-WP-78-4
1978-07 EN E
PUBLICATION TYPE: 3 Report
REP. SOURCE: 0010901 REP. SOURCE NO.: 0344620
KEYWORDS: MINING INDUSTRY, NEW BRUNSWICK, WATER POLLUTION, MINE DRAINAGE, MINE WASTES , WASTE WATER TREATMENT, METALS, EFFLUENTS, FILTRATION, SLUDGE, SLUDGE TREATMENT, LIME NEUTRALIZATION, FLOCCULATION, SLUDGE DEWATERING, LABORATORY TESTS, ANALYTICAL TECHNIQUES, PLANT FACILITIES, COSTS

THE SUITABILITY OF CONVENTIONAL PRECIPITATION AND SEDIMENTATION TECHNIQUES TO REMOVE LEAD, ZINC, COPPER AND IRON FROM VARIOUS TYPES OF ACID MINE DRAINAGE IN NORTHEASTERN NEW BRUNSWICK WAS INVESTIGATED AT PILOT SCALE. THE 0.3 TO 1.0 L PER S (4 TO 13 IGPM) PILOT PLANT WAS DESIGNED FOR LIME AND POLYMER ADDITION, FLOCCULATION, CLARIFICATION, FILTRATION AND SLUDGE RECYCLE. OPTIMUM OPERATING RANGES WERE DETERMINED FOR THE INDIVIDUAL UNIT PROCESSES AND DATA ON ATTAINABLE LEVELS OF EXTRACTABLE AND DISSOLVED METALS ARE PRESENTED. EXPERIMENTS WERE ALSO CONDUCTED TO COMPARE TWO STAGE LIME NEUTRALIZATION TO SINGLE STAGE NEUTRALIZATION AND TO INVESTIGATE SLUDGE DEWATERABILITY AND EFFLUENT TOXICITY. AVERAGE EXTRACTABLE METAL LEVELS ATTAINED AS CLARIFIER OVERFLOW CONCENTRATIONS WERE 0.25 MG PER L LEAD, 0.36 MG PER L ZINC, 0.05 MG PER L COPPER AND 0.28 MG PER L IRON. FURTHER REDUCTIONS WERE ACHIEVED BY SAND FILTRATION. DISSOLVED METAL LEVELS IN THE CLARIFIER OVERFLOW WERE APPROXIMATELY EQUAL TO EXTRACTABLE METAL LEVELS AND WERE UNAFFECTED BY FURTHER POLISHING. NO PERFORMANCE ADVANTAGES WERE DISCERNED USING TWO-STAGE NEUTRALIZATION COMPARED TO SINGLE STAGE. SLUDGE RECYCLE PROVED TO BE AN EFFECTIVE TECHNIQUE TO INCREASE CLARIFIER SLUDGE DENSITY. SLUDGE DEWATERING TESTS INDICATED THAT THE SLUDGE COULD BE EFFECTIVELY DEWATERED BY VACUUM OR PRESSURE FILTRATION. BIOASSAY TESTS SHOWED MEDIAN LETHAL TIMES FOR SALMONID TEST FISH TO BE CONSISTENTLY IN EXCESS

OF 96 HOURS (THE MAXIMUM TEST PERIOD) PROVIDED THAT THE PH WAS ADJUSTED TO NEAR NEUTRAL VALUES BEFORE TESTS WERE CONDUCTED. 22 REF., 7 FIG., 19 TAB.

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RANK =     57            - QL SYSTEMS LIMITED -        D= 15959  CEN

20385          UPDATE NO.: CENV(A)
NELSON MAP-AREA, WEST HALF, BRITISH COLUMBIA (82 F W1/2)
LITTLE HW
AFFILIATION: GEOLOGICAL SURVEY OF CANADA
MEMOIR 308
DEPARTMENT OF MINES AND TECHNICAL SURVEYS.CANADA  OTTAWA ONTARIO
PUBLISHER NO.: M46-308
1960 205 P
PUBLICATION TYPE: 3 Report
REF. SOURCE: 0011001
KEYWORDS: GEOLOGY, DRAINAGE HISTORY, STRATIGRAPHY, PLACER
DEPOSITS, LODE DEPOSITS, LITTLE SLOCAN, FAULTS, FOLDS, MINING,
MINES, MINERALS, PEND OREILLE, KOOTENAY, COLUMBIA
    THE NELSON MAP-AREA (WEST HALF) IS IN SOUTHEASTERN BRITISH
COLUMBIA AND IS APPROXIMATELY 3,110 SQUARE MILES IN AREA.  IT IS
BOUNDED BY THE 49TH AND 50TH PARALLELS OF NORTH LATITUDE AND BY
THE 117TH AND 118TH MERIDIANS OF WEST LONGITUDE.  THE MAJOR
DRAINAGES IN THE AREA ARE THE COLUMBIA, KOOTENAY, SLOCAN, SALMO,
PEND D'OREILLE, AND KASLO RIVERS.  THIS AREA ALSO INCLUDES PARTS
OF LOWER ARROW, SLOCAN, AND THE WEST ARM OF KOOTENAY LAKES.  THE
NELSON MAP-AREA CONSISTS GENERALLY OF SEVERELY FOLDED AND
FAULTED SEDIMENTARY AND VOLCANIC ROCKS REPRESENTING MOST SYSTEMS
FROM WINDERMERE (LATE PRECAMBRIAN) TO THE CRETACEOUS.  THE
REPORT CONTAINS 6 CHAPTERS.  CHAPTER 1 SUMMARIZES PREVIOUS WORK
ON THE AREA AND PRESENTS A BRIEF DESCRIPTION OF THE CLIMATE AND
LOCALITY. CHAPTERS 2 AND 3 DISCUSS THE PHYSICAL FEATURES OF THE
SELKIRK AND MONASHEE MOUNTAINS AND THE GENERAL GEOLOGY OF THE
MAP AREA.  CHAPTERS 4 AND 5 COVER STRUCTURAL GEOLOGY AND
GEOLOGIC HISTORY.  THE FINAL CHAPTER REPORTS ON THE METAL
DEPOSITS IN THE AREA, WHICH INCLUDE, LEAD-SILVER, SILVER-GOLD,
COPPER -SILVER-GOLD, TUNGSTEN, IRON-OXIDE, AND MOLYBDENUM
DEPOSITS.  A SET OF TABLES GIVE DATA ON THE CHEMICAL ANALYSIS OF
PLUTONIC AND VOLCANIC ROCKS, VALHALLA GRANITE AND CORYELL ROCKS.
TWO MAPS ACCOMPANY THE REPORT, ONE SHOWING THE GEOLOGY OF THE
AREA AND THE OTHER GIVING THE NAMES AND LOCATIONS OF MINING
PROPERTIES INCLUDED IN THE WEST HALF OF THE NELSON MAP SHEET.
SERIES STATEMENT:  THE MEMOIR SERIES WAS COMMENCED IN 1910 TO
EMBODY GENERAL FINAL REPORTS ON THE MAIN UNDERTAKINGS OF THE
GEOLOGICAL SURVEY OF CANADA. MAPS FIG REF BC0203-0 BC020400
BC030500 THIS DOCUMENT IS AVAILABLE FROM: UNIVERSITY OF BRITISH
COLUMBIA MAIN LIBRARY CALL NUMBER:  QE185.M7 308

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RANK = 58 - QL SYSTEMS LIMITED - D= 4108 CEN

6386 UPDATE NO.: CENV(A)
RIFFLE ZOOBENTHOS IN STREAMS RECEIVING ACID MINE DRAINAGE
KORYAK M, SHAPIRO MA, SYKORA JL
AFFILIATION: UNIV PITTSBURGH, GRADUATE SCHOOL OF PUBLIC HEALTH,
PITTSBURGH PA
WATER RES WATR-A
PERGAMON PRESS INC, MAXWELL HOUSE, FAIRVIEW PARK ELMSFORD N Y
1972-10 006 010 1239-1247
PUBLICATION TYPE: 1 Article
REF. SOURCE: 0120
KEYWORDS: FAUNA, ACID MINE WASTES, WATER POLLUTION, SULPHURIC
ACID, SPECIES SELECTION, TOXICITY, BIOCOENOSIS, ORGANIC WASTES,
ECOLOGY, MIDGE LARVAE

THE BOTTOM FAUNA OF A STREAM POLLUTED BY ACID MINE DRAINAGE WAS STUDIED IN LOCALITIES IMMEDIATELY INFLUENCED BY MINE DRAINAGE, WHERE VERY LOW ACIDITY VALUES AND HIGH ACIDITIES PREVAIL. THE EFFECT OF ACID MINE WASTES ON THE ECOLOGY AND COMPOSITION OF THE BENTHIC FAUNA IS, IN GENERAL, SIMILAR TO THE EFFECT OF ORGANIC POLLUTION. IN THESE AREAS WE FOUND HIGH NUMBERS OF INDIVIDUALS COMPRISED OF A FEW SPECIES. IN THE ZONES OF ACTIVE NEUTRALIZATION, WHERE IRON HYDROXIDES ARE DEPOSITED, SPECIES DIVERSITY SLIGHTLY INCREASES BUT THE BIOMASS IS VERY LOW. THE MOST NUMEROUS INVERTEBRATES IN THE STREAM SECTIONS EXHIBITING HIGH ACIDITY AND LOW ACIDITY ARE MIDGE LARVAE, ESPECIALLY TENDIPES GR. RIPARIUS. THE NUMBER OF INSECT GROUPS PRESENT INCREASES STEADILY WITH PROGRESSIVE NEUTRALIZATION UNTIL CRUSTACEA (AMPHIPODA) AND OLIGOCHAETA APPEAR, INDICATING CONSIDERABLE IMPROVEMENT IN WATER QUALITY. THE SUPPLY OF DESIRABLE BENTHIC FISH FOOD (TENDIPES SSP.) IS VERY HIGH IN THE PARTS OF THE STREAM WHERE LOW ACIDITY HIGH ACIDITY, AND HIGH FERROUS IRON CONCENTRATIONS PREVAIL. UNFORTUNATELY, FISH CANNOT SURVIVE UNDER THESE CONDITIONS. IN THE LESS ACIDIC ZONES THE DEPOSITION OF FERRIC IRON DRASTICALLY DIMINISHES THE TOTAL BIOMASS OF BENTHIC ORGANISMS AND THEREFORE SEVERELY HARMS FISH POPULATIONS.

* * *

RANK = 59 - QL SYSTEMS LIMITED - D= 1600 CEN

3098 UPDATE NO.: CENV(A)
EFFECTS OF VARIOUS GAS ATMOSPHERES ON THE OXIDATION OF COAL MINE
PYRITES
NUS CORPORATION
U S WATER QUALITY OFFICE
WATER POLLUTION CONTROL RESEARCH
U S GOVERNMENT PRINTING OFFICE WASHINGTON, D C PUBLISHER NO.:
14010ECC
1971-08 154
PUBLICATION TYPE: 3 Report
REF. SOURCE: WATER POLLUTION REF. SOURCE NO.: 1908
KEYWORDS: DRAINAGE, ACID, INERT GAS, NITROGEN, METHANE, CARBON
DIOXIDE, OXIDATION, COAL MINE PYRITE

EXPERIMENTS HAVE SHOWN THAT THE PRODUCTION OF ACID DRAINAGE FROM COAL MINE PYRITE IS PROPORTIONAL TO THE OXYGEN PARTIAL PRESSURE IN THE GAS PHASE IN CONTACT WITH THE PYRITE. OXIDATION OF PYRITE COULD BE REDUCED BY BLANKETING WITH AN INERT GAS; NITROGEN AND METHANE WERE MORE EFFECTIVE THAN CARBON DIOXIDE FOR THIS PURPOSE.

RANK = 60 - QL SYSTEMS LIMITED - D= 385 CEN

883 UPDATE NO.: CENV(A)
STUDIES ON LIMESTONE TREATMENT OF ACID MINE DRAINAGE,
OPTIMIZATION AND DEVELOPMENT OF IMPROVED CHEMICAL TECHNIQUES
BITUMINOUS COAL RESEARCH INCORPORATED
U.S. GOVT PRINTING OFFICE
1970 96
PUBLICATION TYPE: 3 Report
REF. SOURCE: WATER SECTOR LI REF. SOURCE NO.: WASHINGTON, DC
KEYWORDS: NEUTRALIZATION, PARTICLE SIZE, COAL MINE DRAINAGE,
REACTIVITY OF LIMESTONE, LIMESTONE PROCESS, CALCIUM CONTENT,
OXIDATION, MAGNESIUM CONTENT, FERROUS IRON, REACTANT SURFACE
AREA, CARBON CATALYST, ELECTROPHORETIC MOBILITY, SLUDGE REMOVAL,
SLUDGE VOLUME REDUCTION, MAGNETIC SLUDGE, COAGULATION

DATA OBTAINED IN THIS STUDY INDICATE THAT THE LIMESTONE PROCESS FOR NEUTRALIZATION OF COAL MINE DRAINAGE WATERS OFFERS CONSIDERABLE PROMISE FOR AND IMPROVED LOWER COST METHOD. FOUR ACTUAL COAL MINE WATERS WERE NEUTRALIZED WITH LIMESTONE BOTH ON A BATCH SCALE AND BY CONTINUOUS FLOW APPARATUS. A STANDARDIZED TEST WAS ESTABLISHED TO EVALUATE THE REACTIVITY OF THE LIMESTONES AND THE VARIABLES OF IMPORTANCE IN EVALUATION OF THEM FOR THIS PURPOSE ARE PARTICLE SIZE, CALCIUM AND MAGNESIUM CONTENT AND SURFACE AREA. FERROUS IRON OXIDATION, ELECTROPHORETIC MOBILITY, SLUDGE REMOVAL, MAGNETIC SLUDGES AND REDUCTION OF SLUDGE VOLUME WERE ALSO STUDIED. THERE ARE TWENTY-TWO ITEMS IN THE BIBLIOGRAPHY, TWENTY-FIVE TABLES, AND TWENTY-NINE FIGURES.

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RANK = 61 - QL SYSTEMS LIMITED - D= 51799 CEN

57509 UPDATE NO.: CENV82(4)
Water minimization and reuse in mining and milling

Water Pollut Control Dir, Environ Prot Serv
Technology Transfer Seminar on Mining Effluent Regulations/
Guidelines and Effluent Treatment Technology as Applied to
the Base Metal, Iron Ore and Uranium Mining and Milling
Industry. Seminar notes. Sudbury, Ont, November 5-6, 1975,
Montreal, Que, November 17-18, 1975, Banff, Alta, December 9-10,
1975
Environ Prot Serv, Environ Can
1975-10 75p 8 tab LANG.: En
PUBLICATION TYPE: 4 Conference paper
REF. SOURCE: 0010801 REF. SOURCE NO.: WATDOC 57509
NOTES: Seminar sponsored by Environ Prot Serv, Environ Can and
the Can Inst Min Metall
KEYWORDS: mine drainage, mine wastes, water use, metals, mills,
regulations, pollutants, effluents, recycling, surface drainage,
drilling, groundwater, flotation, leaching, ion exchange,
accidents, design, water quality

The Minimization Working Group of the National Mining Effluent Regulations Task Force was directed to examine water management practices within the metals mining industry in order to determine where fresh water usage could be minimized, where water recycle is appropriate and to recommend general practices which would reduce the amount of water contaminated by mining and milling operations. Water has been considered under mining and milling with respect to sources of new water and the water requirements of the unit operations employed. Canadian practice is discussed for various ore groupings with a view to recommending sound engineering practices and practical recycle ratios. Surface drainage and fail-safe design are discussed in order to provide guidance in reducing the net impact of contaminated effluents and unplanned discharges.

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35430 UPDATE NO.: CENT82(1)

The chemical interaction of coal mine drainage and its affect on
acid production of carboniferous shales of eastern Kentucky and
West Virginia
CARUCCIO FT, GEIDEL G
AFFILIATION: Dep Geol, Univ South Carolina, Columbia, SC 29208
US
ED.: CAMPBELL E
3rd Int Symp on Water-Rock Interaction, Edmonton, Alta, July
14-24, 1980
(1980) p140 Int Assoc Geochem and Cosmochem and Alta Res Counc
LANG.: En
PUBLICATION TYPE: A Conference paper
REF. SOURCE: 0010501 REF. SOURCE NO.: OCPP
NOTES: Avail from Dr B Hitchon, Alta Res Counc, 11315 - 87 Ave,
Edmonton, Alta T6G 2C2

KEYWORDS: Kentucky, Virginia, carboniferous shales, rocks,
analysis, acidity, leachate, mine drainage, neutralization,
sampling, Pocahontas Basin

The commonly occurring Carboniferous shales within the Pocahontas Basin of the United States Appalachian coal field have been categorized into seven distinct rock types based on their physical attributes. Thirty three samples representing five of these rock groups were subjected to simulated weathering tests and whole rock analyses. Although a gross correlation exists between rock type and the chemical weathering characterisitcs, a strong relationship was found to exist between the effluent quality and the carbonate-sulfur ratio. This ratio can be used to monitor overburden characteristics in an active mining operation and to identify toxic-acid producing strata. This study also showed that alkaline shale samples with carbonate-sulfur ratios falling on the acid boundary produced acid after being leached for some time with an acidic leachate. It is believed that carbonate material present in the samples inhibits pyrite oxidation and if this material is removed, the sample will produce acid drainage. In view of the acid rain that now occurs in the northeast, the potential of apparently alkaline samples having critical carbonate-pyrite ratios to produce acid becomes a major concern, and may have far reaching implications with regard to mine permitting procedures and overburden management.

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ABS # 61 - CL SYSTEMS LIMITED - D# 39505 CPB

5216 MRBASE NO.: CPAR01(2)
and use and resources, Regional district of Comox-Strathcona
lans Dep, Reg Dist Comox-Strathcona
omox-Strathcona Reg Dist, 4795 Headquarters Rd, Courtenay, BC
9N 5R3
1975) 63p 39 tab, 6 maps LANG.: En
UBLICATION TYPE: 1 Report
SP. SOURCE: 0011481
EOGRAPHIC ID.: W128 00-W124 20/N51 00-N49 30
EYWORDS: British Columbia, Comox, Strathcona, land use,
esources, forestry, agriculture, fishing, physiography, soils,
egetation, hydrology, mining, parks, population
haracteristics, planning

This report is primarily an inventory of land use and
esources in the Comox-Strathcona regional district, covering
he physical environment of the area, the indian peoples,
conomic development and present land use, land status, and
opulation characteristics. The final section of the report
ontains issues for consideration in the formulation of planning
bjectives and alternatives which should be considered before
he adoption of a plan. The district covers 7,830 square miles,
nd had a population of 47,345 in 1971. With the exception of
he eastern coastal plain, the distribution of significant soil
eposits throughout the region is minimal. The dominant soil
eries are outlined. A map presents the location and extent of
he major rivers and drainage basins. Important floral and
aunal habitat types are reviewed and include estuaries, the
arine environments, and alpine areas. The cultural past of the
ndian groups is discussed. The major industry in the area is
orestry. Information is given on forest resources, employment,
ogging volume and value, sawmilling, and pulp and paper. Iron
s mined at Zeballos, and Western Mines at Buttle lake produces
old, silver, copper, lead, zinc, and cadmium. In 1971 there
ere 295 farms with the most important agricultural activity
eing livestock raising. Commercial fishing is based on salmon
ith some shellfish harvesting. The section on land use
iscusses east coast residential development, commercial,
ndustrial, and agricultural land use, parks, and greenbelt
reas. Maps are provided which list the land ownership and use
n the east coast in general and near Courtenay and Campbell
iver. The population distribution, composition, forecast and
abour force and income characteristics are reviewed. The final
ection discusses the constraints which affect development,
otably the shortage of good land, the amount of land held by
rown agencies and forest companies, and the necessity to
rotect the environment.

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BE = 64 - CL SYSTEMS LIMITED - D= 32627 CEN

1281 UPDATE NO.: CENV(A)
PTIMIZATION OF POLYMER FLOCCULATION OF HEAVY METAL HYDROXIDES
ICE PB, MURPHY KL, REED C, LECLAIR BP
FFILIATION: MCMASTER UNIV, HAMILTON, ONT
URNAL WATER POLLUTION CONTROL FEDERATION JWPF-A
1977-12 049 012 2413-2418
BLICATION TYPE: 1 Article
V. SOURCE: 0010501
RIPTORS: HEAVY METALS, ALKALIS (BASES), HYDROXIDES, MINEWATERS,
RON, ZINC, COPPER METALS, SUSPENDED SOLIDS, POLYMER,
LOCCULATION, MIXING CONDITIONS, NEUTRALIZATION, VARIABLES,
UPERNATANT, RESIDUAL CONCENTRATIONS
IN THE TREATMENT OF BASE METAL MINE DRAINAGE, FLOCCULATION
SING SYNTHETIC POLYMERS HAS BEEN DEMONSTRATED TO AID PARTICLE
GGREGATION, THEREBY INCREASING THE SEDIMENTATION RATE IN THE
LARIFIER AND DECREASING THE SUSPENDED SOLIDS CONCENTRATION OF
HE SUPERNATANT. IN THIS STUDY, THE OPTIMUM POLYMER PROPERTIES
ND MIXING CONDITIONS FOR SIMULATED MINEWATERS OF VARIOUS
TRENGTHS WERE OBTAINED USING RESPONSE SURFACE TECHNIQUES.
IXING CONDITIONS PROVED TO BE OF GREATER SIGNIFICANCE THAN
OLYMER PROPERTIES IN OBTAINING MAXIMUM REMOVAL OF PRECIPITATED
ETAL HYDROXIDES OVER A WIDE RANGE OF INITIAL METAL
ONCENTRATIONS. A SUBSTANTIAL DECREASE IN THE MINIMUM REACTION

IME WAS OBSERVED WITH INCREASING WASTE STRENGTH. WORK WAS DONE
N BATCH, BENCH-SCALE EXPERIMENTS USING A SIMULATED MINEWATER
ONTAINING IRON, ZINC, OR COPPER METALS INDIVIDUALLY OR IN
OMBINATION. THESE DATA WERE EMPLOYED TO PREDICT SUCCESSFULLY
E RESIDUAL CONCENTRATIONS OBTAINED WITH AN ACTUAL MINEWATER.
REF, 8 TAB, 5 FIG.

BE = 65 - CL SYSTEMS LIMITED - D= 31047 CEN

067 UPDATE NO.: CENV(A)
INVESTIGATION OF MEGUMA BEDROCK LEACHING IN THE SHUBENACADIE-
EWIACKE RIVER BASIN
CHESCO EN
CHNICAL REPORT NO 8
UBENACADIE-STEWIACKE RIVER BASIN BOARD
78-08 48 P
BLICATION TYPE: 3 Report
V. SOURCE: 0010118
RIPTORS: FISH KILL, WATER QUALITY, SHUBENACADIE RIVER,
OLOGICAL OXIDATION, ENVIRONMENTAL DAMAGE, MINERALIZED SLATE,
ID MINE DRAINAGE, TOXIC METALS, [illegible], IRON, ALUMINUM,
BALT, MANGANESE, ARSENIC, DOMESTIC WATER SUPPLY
FISH KILLS AND DETERIORATED WATER QUALITY IN THE
UBENACADIE RIVER ARE RELATED TO THE MINERALIZED SLATES OF THE
LIFAX FORMATION. THE PREDOMINANT OXIDATION REACTION APPEARS
BE BIOLOGICAL. INDICATIONS ARE THAT THE MOST EFFECTIVE
MEDIAL ACTION IS TO REMOVE THE SOURCE OF AIR BY SEALING
POSED ROCK SURFACES USING CLAY OR ASPHALT. MORE STRINGENT
GULATIONS AND MONITORING WILL BE REQUIRED IN THE FUTURE TO
EVENT ENVIRONMENTAL DAMAGE. 23 REF, 6 FIG, 8 TAB, 10 PHOTOS, 1
P.

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316 UPDATE NO.: CIMV(A)
OCHEMICAL EXPLORATION IN ARCHEAN METAVOLCANIC-METASEDIMENTARY
LTS OF THE PUKASKWA REGION, ONTARIO
LEE EJ.
FILIATION: ONTARIO DIVISION OF MINES, MINISTRY OF NATURAL
SOURCES, TORONTO, ONT
NADIAN MINING AND METALLURGICAL BULLETIN CNMB-A
73-05 066 733 75-83
BLICATION TYPE: 1 Article
P. SOURCE: 0010501

YWORDS: GEOCHEMICAL EXPLORATION, STREAM SEDIMENT CHEMISTRY,
CHEAN ROCKS, PUKASKWA REGION, GLACIAL DEPOSITS, LAKE SUPERIOR
TERSHED, LAKE SUPERIOR, POSTGLACIAL COVER, SOIL GEOCHEMISTRY,
CANADIAN SHIELD

THE APPLICATION OF RECONNAISSANCE STREAM SEDIMENT OCHEMISTRY IN PARTS OF THE UNIVERSITY AND PUKASKWA RIVER SINS HAS CONTRIBUTED TO A RAPID PRELIMINARY EVALUATION OF THE SE METAL POTENTIAL OF THE MAJOR METAVOLCANIC- METASEDIMENTARY LTS AND HAS FURTHER CLARIFIED THE ROLE OF CERTAIN INDEPENDENT RIABLES (I.E., DISTRIBUTIONS OF BEDROCK TYPES, AND PLEISTOCENE RFICIAL DEPOSITS, EH-PH ENVIRONMENTS, SPARSELY MINERALIZED CKS AND METAL- ABSORBING MANGANESE IRON HYDROXIDES) IN NTROLLING REGIONAL GEOCHEMICAL DISPERSION PATTERNS. FAST OWING STREAMS AND RIVERS WITHIN 5 TO 10 MILES OF THE LAKE PERIOR SHORE DRAIN A REGION OF MODERATE TO HIGH RELIEF COVERED A THIN TILL SHEET AND HAVE STEEP GRADIENTS SUITABLE FOR GNIFICANT MECHANICAL TRANSPORT. STREAM SEDIMENT GEOCHEMISTRY N BE APPLIED IN THIS AREA WITH RESULTS SIMILAR TO THOSE PECTABLE IN THE GASPE REGION AND PARTS OF NORTHERN NEW RUNSWICK. REGIONAL PATTERNS OF COPPER, ZINC AND NICKEL STRIBUTION IN BEDROCK AND IN STREAM SEDIMENTS ILLUSTRATED THE SOCIATION OF LOW METAL BACKGROUND IN DRAINAGE SEDIMENTS WITH EAS OF THICK OUTWASH COVER. ANOMALOUS CONCENTRATIONS OF COLD TRATE SOLUBLE TOTAL HEAVY METALS AND HNO3-HCL SOLUBLE COPPER, NC, NICKEL AND COBALT HAVE BEEN OUTLINED IN DRAINAGE ENTERING KE SUPERIOR EAST OF POINT ISACOR BY SAMPLING STREAM AND SPRING DIMENT AT INTERVALS OF 1,500 FEET. DETAILED STREAM SEDIMENT OCHEMISTRY, SOIL GEOCHEMISTRY AND E.M. SURVEYS HAVE BEEN CCESSFULLY USED IN FOLLOW-UP EXPLORATION TO LOCATE DRILL RGETS. 7 REF, 8 FIG.

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SE =    67            - CL SYSTEMS LIMITED -        D=  16071  CEN

 593          UPDATE NO.: CENV(A)
ERATIONAL EXPERIENCE WITH A BASE METAL MINE DRAINAGE PILOT
 ANT
 CE PR, LE CLAIR BP, SHIRLEY PB
FFILIATION: ENVIRONMENTAL PROTECTION SERVICE, ENVIRONMENT
NADA, OTTAWA, ONTARIO
CHNOLOGY DEV REP EPS-4-WP-74-8
VIRONMENT CANADA, ENVIRONMENTAL PROTECTION SERVICE  OTTAWA
 TARIO
74-09 34 P
BLICATION TYPE: 3 Report
P. SOURCE: 8010901
YWORDS: NEW BRUNSWICK, MINING INDUSTRY, MINE WASTES, BASE
TALS, HEAVY METALS, WASTE TREATMENT, TECHNOLOGY, PILOT PLANTS,
OCCULATION, EFFLUENT QUALITY, RESEARCH AND DEVELOPMENT,
LLUTION ABATEMENT, EFFLUENT POLISHING, LEAD, ZINC, COPPER,
ON, SLUDGE HANDLING, EQUIPMENT, OPERATIONS

   THIS REPORT DESCRIBES THE DEVELOPMENT AND EFFECTIVENESS OF
STE TREATMENT PROCESSES FOR BASE METAL MINING WASTES.  THE
TABLISHMENT OF A PILOT PLANT AT BRUNSWICK MINING AND SMELTING
RPORATION'S NO.12 MILL IN NORTHEASTERN NEW BRUNSWICK IS
TAILED AND THE RESULTS OF TESTS USING THREE INFLUENTS OF
RYING STRENGTH ARE REPORTED. POLYMERIC FLOCCULATION, SLUDGE
CYCLING, AND VARIOUS POLISHING TECHNIQUES WERE UTILIZED.  THE
RENGTH OF THE INFLUENT HAD LITTLE EFFECT ON EFFLUENT QUALITY.
FLUENT METAL CONCENTRATIONS ATTAINED WERE:  0.3 MG/L FOR LEAD,
.6 MG/L FOR ZINC, 0.1 MG/L FOR COPPER, AND 0.6 MG/L FOR IRON.
 REF 3 FIG 10 TABLES

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SE =    68            - CL SYSTEMS LIMITED -        D=   2692  CEN

 77           UPDATE NO.: CENV(A)
 N EXCHANGE TREATMENT OF ACID DRAINAGE
 [illegible] JJ, [illegible] HA
FFILIATION: BETHLEHEM STEEL CORPORATION
GINEERING BULLETIN
GINEERING EXTENSION SERIES
RDUE UNIVERSITY  LAFAYETTE, IN  PUBLISHED NO.: 132
1969-04 053 002 101-110
BLICATION TYPE: 5 Proceedings
P. SOURCE: TRANSPORT LIBRA  REF. SOURCE NO.: 628.54.P97
YWORDS: IRON, ACIDITY, PENNSYLVANIA SANITARY WATER BOARD, LIME
TONE, CATIONS, REGENERANT IONS
   THE AUTHORS PRESENT A PILOT PLANT STUDY OF ION EXCHANGE AS A
ANS FOR PRODUCING A CONCENTRATED WASTE STREAM CONTAINING IRON
D ALUMINUM CATIONS AS A MORE ECONOMICAL METHOD OF ACID MINE
AINAGE TREATMENT THAN LIME NEUTRALIZATION.  THE ESTIMATED
GENERANT COSTS FOR MINIMUM-VOLUME, CONCENTRATED WASTE STREAMS
 WELL AS THE SOLIDS CONCENTRATION OF SLUDGES OBTAINED BY
EATMENT OF THIS WASTE STREAM ARE STATED FOR THE PARTICULAR
ID MINE DRAINAGE TREATED.

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NK = 63 - CL SYSTEMS LIMITED - D= 2378 CRR

00 UPDATE NO.: CENV(A)
ALUATION OF A NEW ACID MINE TREATMENT PROCESS
.ACK, SIVALLIS, AND BRYSON INCORPORATED
S WATER QUALITY OFFICE
ATER POLLUTION CONTROL RESEARCH
S GOVERNMENT PRINTING OFFICE WASHINGTON, D C PUBLISHED NO.:
1010EZ1

71-02 170
BLICATION TYPE: 3 Report
F. SOURCE: WATER POLLUTION REF. SOURCE NO.: 1911
YWORDS: COAL REFUSE, OXYGENIZATION, DISTILLATION, COSTS, ACID
NE DRAINAGE, REVERSE OSMOSIS

A METHOD HAS BEEN DEVELOPED FOR TREATMENT OF ACID MINE
RAINAGE, IN WHICH COAL REFUSE IS BURNED IN MOLTEN IRON TO
UPPLY ENERGY FOR DISTILLATION OR REVERSE OSMOSIS OF THE ACID
ATER; THE COAL REFUSE SULPHUR IS TRAPPED IN SLAG FOR SUBSEQUENT
ECOVERY. THE COSTS OF THE PROCESS ARE ESTIMATED.

* * *

ANK = 70 - CI SYSTEMS LIMITED - D= 127 CPR

10 UPDATE NO.: CENV(A)
ASKATCHEWAN RIVER DRAINAGE BASIN; INDUSTRIAL WATER RESOURCES OF
ANADA, WATER SURVEY REPORT 67
JONAS [illegible]
EPT MINES, TECHNICAL SURVEYS OTTAWA
956 154
UBLICATION TYPE: 3 Report
EF. SOURCE: WATER SECTION LI REF. SOURCE NO.: 620.CD, T45
EYWORDS: CHEMICALS, CARBON DIOXIDE, PH, SODIUMPOTASSIUM, IRON,
ARDNESS, SASKATCHEWAN, RIVER, INDUSTRY, WATER QUALITY

THE SEVENTH IN A SERIES OF REPORTS GIVING IN DETAIL THE
ESULTS OF INVESTIGATIONS OF THE CHEMICAL QUALITY OF WATERS
VAILABLE FOR INDUSTRIAL USE IN CANADA. PART I: TABULATES THE
ESULTS OF MONTHLY SAMPLING AND SPOT SAMPLING OF SURFACE WATERS
IN THIS AREA. PART II: TABULATES THE ANALYTICAL DATA ON
UNICIPAL WATER SUPPLIES WITHIN THIS BASIN AND INCLUDES
NFORMATION ON THE OPERATION OF THE VARIOUS SYSTEMS.

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ABN =      71              - QL SYSTEMS LIMITED -         D=     126  CEN

03          UPDATE NO.: CENV(A)
HURCHILL AND MISSISSIPPI RIVER DRAINAGE BASINS (INDUSTRIAL
ATER RESOURCES OF CANADA, SURVEY REPORT 09)
HOMAS JFJ
FFILIATION: ENERGY, MINES AND RESOURCES DEPARTMENT.
958 53
UBLICATION TYPE: 3 Report
EP. SOURCE: WATER SECTOR LI  REP. SOURCE NO.: 610-CDC C2
EYWORDS: CHEMICALS, CARBON DIOXIDE, PH, SODIUM, POTASSIUM,
RON, HARDNESS, CHURCHILL RIVER, INDUSTRY, MISSISSIPPI RIVER,
ATER QUALITY

   THE NINTH IN A SERIES OF REPORTS GIVING IN DETAIL THE
ESULTS OF INVESTIGATIONS OF THE CHEMICAL QUALITY OF WATER
AVAILABLE FOR INDUSTRIAL USE IN CANADA. PART I: TABULATES THE
ESULTS OF MONTHLY SAMPLING AND SPOT SAMPLING OF SURFACE WATERS
N THIS AREA. PART II: TABULATES THE ANALYTICAL DATA ON
UNICIPLE WATER SUPPLIES WITHIN THESE BASINS AND INCLUDES,
NFORMATION ON THE OPERATION OF THE VARIOUS SYSTEMS.

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ABN =      72              - QL SYSTEMS LIMITED -         D=     124  CEN

01          UPDATE NO.: CENV(A)
NDUSTRIAL WATER RESOURCES OF CANADA, SURVEY REPORT #5 SKEENA
IVER DRAINAGE BASIN, VANCOUVER ISLAND AND COASTAL AREA
HOMAS: J FJ
EPARTMENT OF MINES AND TECHNICAL SURVEYS
UBLICATION TYPE: 3 Report
EP. SOURCE: WATER SECTOR LI
EYWORDS: CHEMICALS, CARBON DIOXIDE, PH, SODIUM, POTASSIUM,
RON, NITRITE, NITRATE, HARDNESS, SURFACE WATER, WATER QUALITY
   THIS IS THE FIFTH REPORT IN A SERIES ON THE CHEMICAL QUALITY
F SURFACE WATER AND MUNICIPAL WATER SUPPLIES AVILABLE FOR
NDUSTRIAL AND DOMESTIC USE IN CANADA.  PART 1:  TABULATES THE
ESULTS ON MONTHLY SAMPLING AND SPOT SAMPLING OF SURFACE WATERS
N THIS AREA, CARRIED OUT DURING 1950-1951.  PART 2: TABULATES
THE ANALYTICAL DATA ON MUNICIPAL WATER SUPPLIES WITHIN THE BASIN
AND INCLUDES INFORMATION ON THE OPERATION OF THE VARIOUS
SYSTEMS.

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        2,266 LINES,        72 DOCUMENTS            END OF PRINT REQUEST
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APPENDIX N

CANADIAN ENVIRONMENT (CENV) DATABASE

SEARCH #2 OF 2

SEARCH STRATEGY:

[PYRIT? OR SULPHIDE OR SULFIDE OR IRON]

AND

[TAILING(S)]

NOT

[SEARCH #1]

27891 UPDATE NO.: CENV(A)

CHEMICAL PROCESSES IN ABANDONED SULPHIDE TAILINGS DUMPS AND ENVIRONMENTAL IMPLICATION FOR NORTHEASTERN NEW BRUNSWICK

BOORMAN RS, WATSON DM
AFFILIATION: RESEARCH AND PRODUCTIVITY COUNCIL, FREDERICTON, NB

CANADIAN MINING AND METALLURGICAL BULLETIN CMMB-A
1976-08 C69 772 86-96
PUBLICATION TYPE: 1 Article
REF. SOURCE: 0010501
KEYWORDS: SULPHIDE TAILINGS, TAILINGS DUMPS, ENVIRONMENTAL CONTROL, HEATH STEEL MINES, OXIDATION, CHEMICAL REACTIONS, RECLAMATION, PERMEABILITY, COPPER, ZINC, LEAD, AQUATIC ENVIRONMENT

SAMPLING OF SULPHIDE TAILINGS FROM AN ABANDONED DUMP AT HEATH STEELE MINES LIMITED AND INTERPRETATION OF THE ANALYTICAL RESULTS USING POURBAIX-TYPE STABILITY DIAGRAMS INDICATES THE PRESENCE OF THREE CHEMICAL-PHYSICAL ENVIRONMENTS WITHIN TAILINGS: AN OXIDATION ZONE, EXTENDING TO A MAXIMUM OF 20 INCHES BENEATH THE SURFACE; A HARD PAN, UP TO 6 INCHES THICK BENEATH THE OXIDATION ZONE; AND A REDUCTION ZONE, THE UNDERLYING UNALTERED TAILINGS. LEACHING WITHIN THE OXIDATION ZONE HAS REMOVED 76 PER CENT OF THE COPPER AND 92 PER CENT OF THE ZINC TO A DEPTH OF 10 TO 20 INCHES. GALENA (PBS) IS CONVERTED IN SITU TO INSOLUABLE ANGLESITE (PBSO4) AND, HENCE, LEAD IS REMOVED FROM THE OXIDATION ZONE. THE LEACHING MEDIUM, FERRIC IRON, IS GENERATED THROUGH THE OXIDATION OF PYRITE AND SUBSEQUENT OXIDATION OF FERROUS IRON. THE DEPTH TO WHICH THIS MECHANISM IS OPERATIVE IS RELATED TO THE AVAILABILITY OF OXYGEN FOR BACTERIA WHICH ACT AS A CATALYST IN THE OXIDATION REACTIONS. THE LOW PERMEABILITY OF THESE TAILINGS, LESS THAN 6.65 GALS. PER SQ. FT PER DAY IN THE OXIDATION ZONE, AND PERHAPS LESS THAN 1 GAL. PER SQ. FT PER DAY IN THE REDUCTION ZONE, RESTRICTS THE PENETRATION OF OXYGEN, EITHER AS AIR OR ENTRAINED IN WATER. OXYGEN IS CONSUMED IN THE FIRST FEW INCHES UNTIL THE CONCENTRATION IS NOT SUFFICIENT TO SUPPORT THE REGENERATION OF FERRIC IRON. AT THIS STAGE, THE SOLUBILITY OF FERROUS IRON IS LESS THAN THAT OF THE FERRIC IRON AND DEPOSITION OF IRON OCCURS FROM THE IRON SATURATED SOLUTION TO FORM A WELL DEFINED HARD PAN CONSISTING, IN PART, OF IRON HYDROXIDES AND OXIDES. WITHIN THE HARD PAN, COPPER IS CEMENTED OUT AS CONVELLITE OR OTHER BASE METAL SULPHIDES. THIS HAS RESULTED IN A 95 PER CENT INCREASE IN COPPER CONTENT OVER THE AVERAGE 0.79 PER CENT COPPER IN THE UNDERLYING TAILINGS. WATER PASSING THROUGH THE HARD PAN IS SATURATED WITH IRON, UP TO 3.61 WT. PER CENT, (36,100 PPM), WHICH IS ALMOST COMPLETELY REDUCED TO THE FERROUS STATE. COPPER IN SOLUTION IS DECREASED FROM SEVERAL HUNDRED PPM ABOVE THE HARD PAN TO AN AVERAGE OF APPROXIMATELY 1 PPM IN THE REDUCTION ZONE. AVERAGING 5.5 PPM, TENDS TO BE SLIGHTLY FROM SEVERAL THOUSAND PPM TO LESS THAN 300 PPM, BUT MORE THAN 20 PPM. THE LEAD CONTENT IN WATER FROM THE REDUCTION ZONE, AVERAGING 5.5 PPM, TENDS TO BE SLIGHTLY HIGHER THAN IN THE OXIDATION ZONE. 5 REF. 8 FIG. 8 TAB.

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RANK =      2              - QL SYSTEMS LIMITED -        D= 25774  CEN

31284           UPDATE NO.: CENV(A)
VEGETATING THE URANIUM MINE TAILINGS AT ELLIOT LAKE, ONTARIO
MURRAY D, MOFFETT D
AFFILIATION: DEPT ENERGY, MINES AND RESOURCES, ELLIOT LAKE,
ONTARIO
JOURNAL OF SOIL AND WATER CONSERVATION JSWC-A
1977-07 032 004 171-174
PUBLICATION TYPE: 1 Article
REF. SOURCE: 0010501
KEYWORDS: URANIUM MINE TAILINGS, ELLIOT LAKE, ONTARIO,
REVEGETATION, LIMESTONE, GRASSES, LEGUMES, HERBAGE YIELD,
GROUNDCOVER, FERTILIZERS, ANNUALS, SEEDING, TAILINGS VEGETATION
    THE AUTHORS REVEGETATED PYRITIC URANIUM TAILINGS NEAR ELLIOT
LAKE, ONTARIO, WITH A SURFACE APPLICATION OF LIMESTONE (2.24
KILOGRAMS PER SQUARE METER (10 TONS PER ACRE)) TO NEUTRALIZE
ACIDITY AND FERTILIZERS TO COMPENSATE FOR THE LACK OF NUTRIENTS
AND A VERY LOW CATION EXCHANGE CAPACITY.  THE STUDY INVOLVED NO
SUPPLEMENTAL ORGANIC MATTER OR TOPSOIL.  THEY SEEDED 24 GRASSES,
LEGUMES, AND ANNUALS IN FIELD PLOTS, 3 METERS BY 6 METERS (10
FEET BY 20 FEET).  SIX GRASSES AND THREE LEGUMES PERSISTED OVER
FOUR GROWING SEASONS.  THEY BASED SPECIES SELECTION ON HERBAGE
YIELD, PERCENT GROUNDCOVER, AND FIELD OBSERVATIONS.  REED
CANARYGRASS PROVED TO BE THE MOST SUCCESSFUL SPECIES, BUT A
MIXTURE OF CREEPING RED FESCUE WITH REDTOP OR KENTUCKY BLUEGRASS
SEEMED PREFERABLE BECAUSE OF ITS SUPERIOR SOD FORMING ABILITIES.
LEGUMES PERFORMED SO POORLY THAT THE AUTHORS DO NOT RECOMMEND
THEIR INCORPORATION IN SEED MIXTURES. 4 REF, 5 TAB, 1 FIG.

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28886 UPDATE NO.: CENV(A)

AN INVESTIGATION INTO THE EFFECTS OF A LEAD - ZINC MINE ON THE AQUATIC ENVIRONMENT OF GREAT SLAVE LAKE

STEIN JN, MILLER MD
RESOURCE DEVELOPMENT BRANCH, FISHERIES SERVICE, DEPT OF THE ENVIRONMENT WINNIPEG, MANITOBA

1972-04 56 P
PUBLICATION TYPE: 3 Report
REF. SOURCE: 4030201 REF. SOURCE NO.: BI22076

KEYWORDS: MACKENZIE RIVER BASIN, WATER POLLUTION, INDUSTRIAL WASTES, MINE WASTES, AQUATIC LIFE, TAILWATER, HEAVY METALS, CHEMICAL WASTES, BIOASSAY, GREAT SLAVE LAKE, PINE POINT, LEAD, ZINC, SEDIMENTS, ENVIRONMENTAL EFFECTS

DURING THE SUMMER OF 1971, AN INVESTIGATION WAS MADE INTO THE EFFECTS OF A LEAD - ZINC MINE ON THE AQUATIC BIOLOGY OF GREAT SLAVE LAKE. TWENTY-FIVE SAMPLING LOCATIONS WERE ESTABLISHED AT VARIOUS POINTS IN AND AROUND THE COMINCO PROPERTY AT PINE POINT, N.W.T. TWO LITRE SURFACE WATER SAMPLES WERE COLLECTED BI-MONTHLY FROM EACH STATION. CHEMICAL ANALYSIS RESULTS WERE HIGHLY VARIABLE, ALTHOUGH THE LEVELS OF HEAVY METALS FOUND INCREASED IN THE PROXIMITY OF THE MINE. IT WAS NOT POSSIBLE TO ACCURATELY DETERMINE CHEMISTRY CHANGES BETWEEN THE MINE AND THE LAKE. SEDIMENT AND VEGETATION SAMPLES WERE COLLECTED MONTHLY ON SEVERAL STATIONS. ANALYSIS RESULTS INDICATED A SUBSTANTIAL AREA OF THE MUSKEG WAS BEING CONTAMINATED BY MINE EFFLUENT. EXTREMES IN THE HEAVY METAL LEVELS DETECTED WERE ATTRIBUTED TO INEFFICIENT OPERATION OF THE TAILINGS DISPOSAL SYSTEM DURING PERIODS OF INCREASED MILL DISCHARGE OR RUNOFF. GREATER AMOUNTS OF THE METALS WERE CONCENTRATED IN ROOTS THAN IN OTHER SECTIONS OF THE PLANTS. INVERTEBRATE SAMPLES WERE OBTAINED MONTHLY USING AN EKMAN DREDGE OR SURBER SAMPLER. NO INVERTEBRATES OF ANY SPECIES WERE FOUND IN THE VICINITY OF THE TAILINGS AREA. GILL NETS OF VARIOUS MESH SIZES WERE USED TO COLLECT FISH SAMPLES THREE TIMES DURING THE SUMMER. SKINNED FILLETS AND LIVERS WERE SUBJECTED TO HEAVY METAL ANALYSIS. SAMPLES TAKEN FROM THE PROXIMITY OF THE MINE GENERALLY CONTAINED GREATER AMOUNTS OF ZINC AND COPPER THAN THOSE FROM OTHER AREAS. NO RELATIONSHIP WAS FOUND BETWEEN HEAVY METAL LEVELS AND FISH WEIGHT, OR BETWEEN THE LEVELS AND SAMPLING TIME. NO SIGNIFICANT TRENDS WERE NOTED IN THE LEVELS OF LEAD, CADMIUM, MERCUR, NICKEL, IRON, MANGANESE OR CHLORINATED HYDROCARBONS FOUND. TOKEN BIOASSAY TESTS WERE CONDUCTED AT FOUR LOCATIONS NEAR THE TAILINGS DISPOSAL AREA. HEAVIEST MORTALITY OCCURRED WITHIN THE FIRST 48 HOURS. SUFFOCATION WAS INDICATED AS A PRINCIPAL CAUSE OF DEATH. BASED ON THE FEW SAMPLES COLLECTED, IT IS CONCLUDED THAT A LARGE AREA OF THE MUSKEG AND, TO A DEGREE, THE FISH RESOURCES IN THE PINE POINT AREA, ARE BEING CONTAMINATED BY MINE EFFLUENT. EXISTING TAILINGS DISPOSAL FACILITIES ARE INADEQUATE TO ENSURE THAT INCREASED AMOUNTS OF EFFLUENT DO NOT REACH GREAT SLAVE LAKE. RECOMMENDATIONS FOR AN IMPROVED SYSTEM INCLUDE THE FOLLOWING ALTERNATIVES: 1) COMPLETE IN-MILL RECYCLING OF ALL EFFLUENT. 2) ESTABLISHMENT OF A SERIES OF TAILING PONDS TO INCREASE SETTLING TIME WITHIN THE SYSTEM. 3) INCREASE THE HEIGHTS AND LENGTHS OF THE EXISTING DYKES TO CREATE A COMPLETE RETENTION SYSTEM. 19 FIG, 10 TAB, 4 APP, 10 REF, 12 MAPS.

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BANK =      4              - QL SYSTEMS LIMITED -          D= 22563  CEN

27890            UPDATE NO.: CENV(A)
USE OF SCATTERED RADIATION IN THE DETERMINATION OF COPPER IN
MINERAL SLURRIES
KAWATRA SK
AFFILIATION: CANMET, DEPT ENERGY, MINES AND RESOURCES, OTTAWA
CANADIAN MINING AND METALLURGICAL BULLETIN CMME-A
1976-08 069 772 97-100
PUBLICATION TYPE: 1 Article
REF. SOURCE: 0010501
KEYWORDS: SCATTERED RADIATION, PROCESS CONTROL, FLOTATION,
REAGENTS, ANALYSIS, COPPER, MINERAL SLURRIES, CHEMICAL REAGENTS,
TAILINGS, HEAVY METALS, X-RAYS
    A 'COPPER PROBE' EMPLOYING A PLUTONIUM 238 SOURCE AND A
SCINTILLATION DETECTOR WAS TESTED EXTENSIVELY IN A CLOSEDLOOP
TEST RIG AT MOUNT ISA MINES LTD., MOUNT ISA, AUSTRALIA.  A
SLURRY SAMPLE WAS CIRCULATED IN THE TEST RIG AND THE PROBE WAS
IMMERSED INSIDE THE SLURRY.  THE SAMPLE WAS EXCITED BY THE LOW
ENERGY GAMMA RAYS, AND THE FLUORESCENT X-RAYS EMITTED FROM THE
SAMPLE WERE FILTERED AND DETECTED BY A SCINTILLATION DETECTOR.
BECAUSE SCINTILLATION DETECTORS CANNOT RESOLVE THE ENERGIES OF
THE FLUORESCENT X-RAYS OF SUCH COMMON ELEMENTS AS COPPER AND
IRON FOUND IN ORES, IT WAS DECIDED TO USE THE RADIATION
SCATTERED BY THE SAMPLE FOR THE CORRECTION OF 'MATRIX' ERRORS.
THE INTENSITIES OF THE FLUORESCENT X-RAYS AND THE SCATTERED
RADIATION WERE MEASURED IN TWO DIFFERENT CHANNELS.  IN ADDITION,
A DENSITY GAUGE, EMPLOYING A CESIUM 137 SOURCE, WAS INCORPORATED
IN THE TEST RIG.  THE SIGNALS FROM THE DENSITY GAUGE PROVIDED A
CORRECTION FOR THE VARIATION OF PER CENT SOLIDS IN THE SLURRY.
COPPER IN THE 'FEED' SAMPLES WAS DETERMINED WITH A STANDARD
DEVIATION OF 0.15 PER CENT (RANGE OF COPPER ASSAY: 2.05 TO 4.87
PER CENT), WHEREAS COPPER IN THE 'CONCENTRATE' SAMPLES WAS
DETERMINED WITH A STANDARD DEVIATION OF 0.48 PER CENT (RANGE OF
COPPER ASSAY:  15.9 TO 31.2 PER CENT).  HOWEVER, FOR 'TAILING'
SAMPLES, NO CORRELATION BETWEEN THE COPPER ASSAY AND THE
INTENSITY OF THE FLUORESCENT X-RAYS COULD BE OBTAINED.  THUS, IT
WAS CONCLUDED THAT THE SCATTERED RADIATION PROVIDED A SUITABLE
'MATRIX' CORRECTION FOR THE FEED AND CONCENTRATE SAMPLES.
HOWEVER, FOR THE ANALYSIS OF 'TAILING' SAMPLES AN ADDITIONAL
'IRON PROBE' FOR THE CORRECTION OF 'MATRIX' ERRORS DUE TO
VARIATION OF IRON IN THE SLURRY WAS REQUIRED. 7 REF.  7 FIG.  1
TAB.

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20252 UPDATE NO.: CENV(A)
PRELIMINARY REPORT ON POLLUTION OF WATERS OF MOYIE AND KOOTENAY RIVERS

REED CE
AFFILIATION: DEPT OF THE INTERIOR CAN DOMINION WATER POWER AND RECLAMATION SERVICE

UNPUBLISHED
1926-08 12 E

PUBLICATION TYPE: 3 Report
REF. SOURCE: C011001
KEYWORDS: KOOTENAYS, MOYIE LAKE, MOYIE RIVER, POLLUTION, COMINCO, TAILINGS, FISH, POLLUTION CONTROL, POLLUTANTS, TOXINS, MINE WASTES, HEAVY METALS, POLLUTION INVESTIGATIONS

THIS REPORT PRESENTS THE PRELIMINARY RESULTS OF AN INVESTIGATION INTO THE ALLEGED POLLUTION BY MINE WASTES FROM THE ST. EUGENE CONCENTRATOR OF THE CONSOLIDATED MINING AND SMELTING COMPANY OF CANADA, LTD., AT MOYIE, BRITISH COLUMBIA. THE CONCENTRATOR WAS LOCATED ON THE EAST SHORE OF MOYIE LAKE. ROD AND GUN CLUBS AND RESIDENTS IN RELEVANT AREAS ALONG THE MOYIE RIVER WERE INTERVIEWED TO OBTAIN THE LOCAL VIEWPOINT. SAMPLES OF WATER WERE TAKEN FOR ANALYSIS. AT THE TIME OF THE INVESTIGATION THE MOYIE RIVER WAS AT AN EXTREMELY LOW STAGE WHICH WOULD MAKE ANY POLLUTION MORE NOTICEABLE. THE MILL HAD A CAPACITY OF 500 TONS OF ORE PER DAY. TAILINGS FROM THE MILL ARE RUN OUT ON A FLOATING LAUNDER FOR A DISTANCE OF 200 FEET WHERE THEY ARE DUMPED INTO A 3 FT. DIAMETER CYLINDER WHICH EXTENDS ABOUT 15 FT. BELOW THE SURFACE. AS WAVE AND WIND ACTION WILL NOT AFFECT THE WATER BELOW 10 FT. THE TAILINGS ARE ALLOWED TO SETTLE OUT IN STILL WATER. RE-AGENTS USED IN CONCENTRATION: SODA ASH, COPPER SULPHATE, SODIUM CYANIDE, CRESYLIC ACID, AND FLOTATION OILS. THE MILL IS RE -PROCESSING A MIDDLING PRODUCT FROM KIMBERLY AND WILL LATER PROCESS OLD TAILING WHICH WILL BE A MIXTURE OF LEAD, ZINC AND IRON SULPHIDES. NO DIRECT EVIDENCE OF POLLUTION WAS FOUND. FISH LIFE IS LIABLE TO CRESYLIC ACID, AND FLOTATION OILS. THE MILL IS RE -PROCESSING A MIDDLING PRODUCT FROM KIMBERLY AND WILL LATER PROCESS OLD TAILING WHICH WILL BE A MIXTURE OF LEAD, ZINC AND IRON SULPHIDES. NO DIRECT EVIDENCE OF POLLUTION WAS FOUND. FISH LIFE IS LIABLE TO R.D.C. OVER POLLUTION FROM THE MILL WAS MORE OR LESS PREMATURE. RESULTS OF THE WATER ANALYSIS APPEARED IN A LATER REPORT. 1 MAP 2 FIG 5 PHOTOGRAPHS. PC020313. THIS DOCUMENT IS AVAILABLE FROM: WATER SURVEY OF CANADA, INLAND WATERS DIRECTORATE, PACIFIC REGION, ENVIRONMENT CANADA, VANCOUVER, B.C.

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40886 UPDATE NO.: CINE81(5)

An Environmental Baseline Survey - 1973, Sam Goosly project for Equity Mining Capital Ltd.
SAGAR JR, BRECHAN D
AFFILIATION: TW Beak Consultants Ltd
Beak Consultants Ltd, Vancouver, BC
1974-01 30p; 3 app, 2 tab LANG.: En
PUBLICATION TYPE: 3 Report
REF. SOURCE: 0011481
NOTES: Report prepared for Equity Mining Capital Ltd, Houston,

BC
GEOGRAPHIC ID.: W126 15,N54 10
KEYWORDS: British Columbia, Houston, Buck Creek, mining, copper, antimony, silver, gold, heavy metals, water quality, water pollution, benthic invertebrates, mayflies, stoneflies, fluoride, iron, water chemistry

The objective of this report is to document the pre-operational physical, chemical, and biological characteristics of the region surrounding the Sam Goosly property near Houston BC. A proposed mine development in the area for copper, silver, gold, and antimony will include an open pit mine, milling facilities, antimony leaching facilities, and a tailings pond. Two pre-operational surveys of the area were conducted in July and October of 1973 to provide baseline data of the area's watercourses under both summer and fall conditions. Water samples were collected from 2 locations in Foxy Creek and from 6 locations in Buck Creek. Benthic invertebrates were collected with a Surber Sampler. Chemical analyses showed that in general, all stations were very similar chemically during both surveys. The pH was close to neutrality in all cases and cyanide, silver, arsenic, mercury, lead, antimony, and zinc were not detected. Small amounts of copper, fluoride, and iron were detected and the amount varied between stations. The biological surveys showed that all stations supported a similar benthic community. Mayflies and stoneflies indicative of clean water were present at all stations. The preliminary results suggest that the streams sampled are typical of [illegible]ched, clean, mountain type streams found in northern [illegible]umbia. Buck creek and Foxy creek appear to be [illegible] habitat for fish. It is recommended that any future [illegible] program test for sulphide, sulphate, chemical oxygen [illegible] and grease. These substances may reach the creek [illegible] as a result of mining and milling methods likely to be used.

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30651 SERIAL NO.: CENV(A)
RADIOLOGICAL INVESTIGATIONS OF AN ABANDONED URANIUM TAILINGS AREA
MOFFETT D, TELLIER M
AFFILIATION: RIO ALGOM LTD, ELLIOT LAKE, ONT
JOURNAL OF ENVIRONMENTAL QUALITY JEVQ-A
1978-07 007.003 310-314
PUBLICATION TYPE: 1 Article
REF. SOURCE: 0010501
KEYWORDS: RADIOACTIVITY, ELLIOT LAKE, ON-SITE INVESTIGATIONS, URANIUM RADIOISOTOPES, URANIUM TAILINGS, WATER SAMPLING, TEST WELLS, ANALYTICAL TECHNIQUES, WATER TABLE, WATER QUALITY, ACIDIC WATER, WATER POLLUTION

TAILINGS HAVE BEEN ACCUMULATING IN THE ELLIOT LAKE AREA SINCE MINING STARTED SOME 20 YEARS AGO. THE TAILINGS SOLIDS WERE IMPOUNDED BY CONSTRUCTION OF DAMS, RESULTING IN THE DISCHARGE OF A CLEAR AND NEUTRAL OUTFLOW WHICH AT THAT TIME WAS CONSIDERED TO BE A SATISFACTORY PRACTICE. HOWEVER, ACID GENERATED IN THE TAILINGS BY OXIDATION OF PYRITE HAS SOLUBILIZED CERTAIN HEAVY METALS WHICH CAN ESCAPE THROUGH THE SEMIPERVIOUS EMBANKMENTS OR AS OUTFLOW DURING HEAVY RAINFALLS. IT IS NOW EVIDENT THAT THESE AREAS, SOME OF WHICH HAVE BEEN IDLE FOR OVER 12 YEARS, RELEASE ACIDS AND CERTAIN NATURALLY OCCURRING RADIONUCLIDES TO AN UNACCEPTABLE DEGREE. IN MOST CASES THE ACID TAILINGS OUTFLOWS ARE NEUTRALIZED TO PH 9.5 TO PRECIPITATE THESE HEAVY METALS. THIS NEUTRALIZATION WILL HAVE TO BE CONTINUED INDEFINITELY, UNLESS A BETTER REMEDY IS FOUND. AN INVESTIGATION IS UNDERWAY AT A 16-HA PYRITE CONTAINING URANIUM TAILINGS AREA TO DETERMINE WHAT HAPPENS TO CERTAIN RADIOACTIVE ELEMENTS. THE ANALYSIS OF SOLID SAMPLES SHOWED THE ACTIVITIES OF 226RA, 210PB, AND 210PO WERE LOWER THAN COULD BE ACCOUNTED FOR BY THEIR RADIOACTIVE DECAY SINCE DISPOSAL. URANIUM AND THORIUM ALSO HAVE BEEN SIGNIFICANTLY LEACHED OUT OF THE TAILINGS SURFACE. THE COLLECTION AND ANALYSIS OF WATER SAMPLES FROM THE WATER TABLE BENEATH THE TAILINGS AREA REVEALED TWO CLASSES OF WATER: A LOW ACID CLASS(LESS THAN 1,000 PPM ACIDITY) AND A HIGH ACID CLASS. THE ACIDITY OF THE WATER WAS DIRECTLY RELATED TO THE WEATHERING OF PYRITE IN THE SURFACE LAYERS OF THE TAILINGS. THE HIGH-ACID WATER SAMPLES GENERALLY CONTAINED HIGHER CONCENTRATIONS OF 210PB, 232TH, 230TH, 228TH, AND URANIUM THAN LOW ACID WATER SAMPLES. THE LOW-ACID WATER SAMPLES CONTAINED ONLY ELEVATED CONCENTRATIONS OF 226RA WHICH, IF RELEASED UNTREATED, WOULD EXCEED WATER QUALITY CRITERIA. SEEPAGE SAMPLES BELOW THE TAILINGS DAM WERE ALSO MONITORED AND ANALYZED, AND MAY EXCEED DESIRABLE WATER QUALITY CRITERIA FOR 226RA AND 210PB IF NOT TREATED. 2 TAB, 12 REF, 3 FIG.

33292 UPDATE NO.: CEEV(A)
THE IMPACT OF TACONITE TAILINGS ON DISSOLVED SOLIDS
CONCENTRATIONS IN LAKE SUPERIOR
PLUMB RH, LEE GF
AFFILIATION: U.S. ARMY CORPS OF ENGINEERS WATERWAYS EXPERIMENT
STATION, MS-USA
INTERACTIONS BETWEEN SEDIMENTS AND FRESH WATER, AMSTERDAM, SEPT
6.-10., 1976
DR W. JUNK B.V. PUBLISHERS THE HAGUE, NL PUBLISHER NO.:
C2471ISC.2
1977 423-430
PUBLICATION TYPE: 5 Proceedings
REF. SOURCE: 0010501
KEYWORDS: WATER, LAKES, LAKE SUPERIOR, TAILINGS, TACONITE,

DISSOLVED SOLIDS CONCENTRATIONS, ALKALINITY, SEDIMENTS,
INTERSTITIAL WATERS, MINE TAILINGS, MINERALS, DISSOLUTION

THIS PAPER WAS PRESENTED AT THE PROCEEDINGS OF AN INTERNATIONAL SYMPOSIUM HELD AT AMSTERDAM, THE NETHERLANDS, SEPTEMBER, 6-10, 1976. AN IRON ORE MINING BENEFICIATION PLANT DISCHARGES APPROXIMATELY 60,000 METRIC TONS PER DAY OF TACONITE TAILINGS (FINELY DIVIDED CRUSHED ROCK) TO LAKE SUPERIOR. THESE TAILINGS ARE COMPOSED PRIMARILY OF QUARTZ AND AN AMPHIBOLE CUMMINGTONITE, A FEW PERCENT IRON MINERALS AND OTHER TRACE MINERALS. SEVERAL YEARS LEACHING TESTS HAVE SHOWN THAT TACONITE TAILINGS SOLUBILITY RANGES FROM 0.03 TO 1.2 PERCENT, WITH THE LATTER FIGURE REPRESENTING THE MAXIMUM POSSIBLE RELEASE UNDER LABORATORY CONDITIONS SIMULATING THE LAKE SUPERIOR ENVIRONMENT. UNDER THESE CONDITIONS THE ALKALINITY IN THE LAKE MIGHT INCREASE UP TO 2 MG PER L AFTER 50 YEARS OF DISCHARGE. THE TOTAL DISSOLVED SOLIDS CONTENT OF THE LAKE IS IN THE ORDER OF 57 MG PER L. THE MAXIMUM POSSIBLE INCREASE IN DISSOLVED SOLIDS AFTER 50 YEARS OF OPERATION WOULD BE IN THE ORDER OF 3 MG PER L. THESE COMPUTATIONS ASSUME THAT ALL DISSOLVED SOLIDS ADDED TO THE LAKE ARE CONSERVATIVE, I.E., REMAIN IN SOLUTION AND ARE ONLY REMOVED BY OUTFLOW FROM THE LAKE WITH NO INCORPORATION INTO THE SEDIMENTS. A FIELD STUDY DEMONSTRATED THAT THE CONCENTRATIONS OF VARIOUS MAJOR DISSOLVED SOLIDS IN THE INTERSTITIAL WATERS WHERE TACONITE TAILINGS HAVE BEEN DEPOSITED PREVIOUSLY WERE ELEVATED ABOVE THE CONCENTRATIONS IN AREAS WHERE THERE HAD BEEN NO TACONITE TAILINGS DEPOSITED. HOWEVER, MEASUREMENTS IMMEDIATELY ABOVE THE SEDIMENT-WATER INTERFACE SHOWED THAT THE RATE OF TRANSPORT FROM THE SEDIMENTS TO THE OVERLYING WATERS WAS SUFFICIENTLY SLOW SO THAT THERE WAS NO DETECTABLE CHANGE IN THE CONCENTRATIONS OF DISSOLVED SOLIDS IN THE AREAS WHERE THE SEDIMENTS WERE COVERED WITH TACONITE TAILINGS COMPARED TO NON-TAILINGS AREA. IT IS CONCLUDED THAT PAST AND FUTURE DISCHARGES OF TACONITE TAILINGS WOULD HAVE NO SIGNIFICANT IMPACT ON DISSOLVED SOLIDS CONCENTRATIONS IN LAKE SUPERIOR. 22 REF, 5 TAB, 1 FIG.

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57419 UPDATE NO.: CENV82(4)

Contaminant migration in a sand aquifer near an inactive uranium tailings impoundment, Elliot Lake, Ontario

MORIN KA, CHERRY JA, LIM TP, VIVYURKA AJ
AFFILIATION: Dep Earth Sci, Univ Waterloo, Waterloo, Ont N2L 3G1

Can Geotech J CGJOAH
ISSN 0008-3674
1982-02 19(1) 49-62 11 ref, 13 fig, 1 tab LANG.: En
PUBLICATION TYPE: 1 Article
REF. SOURCE: 0010501
NOTES: Funded by Can Dep Energy, Mines Resour grant
GEOGRAPHIC LC.: W82 46,N46 22

KEYWORDS: Elliot Lake, Ontario, uranium, mine wastes, reservoirs, sand aquifers, piezometers, chemical analysis, water sampling, groundwater pollution, stratigraphy, hydrogen ion concentration, plumes, radium, model studies

An investigation of the movement of contaminated groundwater from inactive uranium tailings through a sand aquifer is being conducted at the Nordic Main tailings impoundment near Elliot Lake, Ontario. During 1979 and 1980, multilevel bundle-type piezometers were installed at several locations around the edge of the tailings impoundment. Chemical analysis of water samples from the bundle piezometers indicate that major contaminant plume extends outward through a sand aquifer from the southeastern part of the Nordic Main impoundment dam. In the vicinity of the contaminant plume, the sand aquifer varies in thickness from about 9 to 15 m. The plume has two distinct segments, referred to as the inner core and the outer zone. The inner core, which has a pH of 4.3 - 5.0 and extends about 15 m from the foot of the tailings dam, contains several grams per litre of iron and sulfate, and tens of pCi/L 226 Ra or 210 Pb. Water levels in piezometers within the inner core show that groundwater is moving horizontally, away from the tailings impoundment, with a velocity of up to several hundred metres per year. The outer zone, which extends a few hundred metres downgradient from the dam, is characterized by hundreds to thousands of milligrams per litre of iron and sulfate, less than 15 pCi/L of 226 Ra, and a pH greater than 5.7. Comparison of 1979 and 1980 data shows that the front of the inner core is advancing a few metres per year, which is less than a few percentage of the groundwater velocity. This retardation of movement of the inner core is caused by neutralization of the acidic water as a result of dissolution of calcium carbonate in the sand. With the rise in pH, precipitation of iron carbonate and possibly some iron hydroxide occurs and the contaminants of main concern such as 226 Ra, 210 Pb, and uranium are removed from solution by adsorption or coprecipitation.

* * *

BANK = 10 - CL SYSTEMS LIMITED - D= 45446 CIN

51153 UPDATE NO.: CISV81(7)
Availability of metals from inorganic particulates (mine tailings) for uptake by marine invertebrates
MCGREER ER, REID BJ, VIGERS GA
AFFILIATION: EVS Consultants Ltd
EVS Consultants Ltd. 195 Pemberton Ave, North Vancouver, BC, V7P 2R4
1980-03 40p 11 fig, 4 tab, 18 ref LANG.: En
PUBLICATION TYPE: 1 Report
REF. SOURCE: 0011481
NOTES: Report prepared for the Dept Fish Oceans, West Vancouver Lab, 4160 Marine Dr, West Vancouver, BC, V7V 1N6; project 646

KEYWORDS: British Columbia, mine tailings, environmental contamination, heavy metals, copper, lead, zinc, cadmium, iron, marine invertebrates, mussels, clams, metal bioaccumulation, water salinity, water temperature

The availability of heavy metals (Cu, Pb, Zn, Cd and Fe) from three mine tailings for uptake by marine invertebrates was determined under different salinity and temperature conditions. A filter feeding mussel, Mytilus edulis, and a deposit feeding clam, Macoma balthica, were used as test organisms. All metals bioaccumulated to their highest concentrations in tailings from the Granduc mine. No direct relationship between metal uptake and salinity or temperature was apparent. Levels of metals in tissues of M. balthica were generally proportional to their concentration in seawater. Concentrations of dissolved Cu, Zn and Fe were consistently higher in tests carried out at 5 C than at 15 C. In leaching tests carried out under different salinity and oxygen conditions, the concentrations of dissolved metals increased with increasing salinity and dissolved oxygen levels. However, the metalbinding associations within the tailings were considered to be the prime controlling factors in determining metal release. Results of laboratory leaching and bioaccumulation studies were consistent with data reported in the literature for discharge of the tailings into the sea.

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RANK =      11          - CL SYSTEMS LIMITED  -        D=  39257  CEN

44962          UPDATE NO.: CENV81(1)
Island Copper Mine, Utah Mines Ltd., Annual Environmental
Assessment Report 1977, Vol 1
Utah Mines Ltd
1977 92p 26 tab, 24 fig, 17 ref  LANG.: En
PUBLICATION TYPE: 3 Report
REF. SOURCE: 0011481
NOTES: Environmental Monitoring required by Pollution Control
Branch Permit PE-379
GEOGRAPHIC ID.: W127 50-W127 25/N50 40-N50 25
KEYWORDS: British Columbia, Rupert Inlet, Quatsino Sound,
Holberg Inlet, mining, mill effluent, environmental surveys,
heavy metals, marine environments, benthic organisms, bio-
assays, salmon, tailings deposition, primary productivity
    The report presents the results of the 1977 environmental
monitoring program on the effects of the copper - molybdenum
mine mill effluent on the Rupert Inlet environment.  Mill
effluent met all of the limits of acceptability as outlined in
the pollution permit PE-379 for pH, total solids, particulate
mercury and cyanide, and dissolved copper, molybdenum, arsenic,
zinc, manganese, lead, iron, nickel, cobalt, chromium, and
cadmium.  Monthly bio-assays of mill effluent on juvenile coho
salmon resulted in a 100% survival rate. Accumulation of
tailings in the inlet resulted in no statistically significant

differences in turbidity at depths less than 100 feet between
any of the sampling stations.  All stations except one had
increases in deep water turbidity over their pre-operational
levels.  Echo soundings and seismic profiling indicated an
average increase of one half foot per month in tailings
thickness in the trough of Rupert Inlet during the sixth
production year.  Tailings extended about 8 km up Rupert Inlet
and 11.3 km up Holberg Inlet. No tailings were noticed in
Quatsino Sound.  No statistically significant differences were
observed in the biological standing crop or productivity between
stations.  Primary productivity levels were similar to values
from other geographical areas. Zooplankton diversity had
increased from pre-operational levels. Benthic organisms had
increased since the fifth production year. Benthic fauna
suppression may be related to bottom stability and not just the
presence or absence of significant amounts of tailings. Seawater
analysis showed a slight increase in particulate copper and
dissolved and particulate manganese, particulate iron, and total
arsenic.  Tissue metal levels of selected invertebrates has not
shown a significant increase since the start of operations.
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BANK =      12              - QL SYSTEMS LIMITED -          D=  27832  CEN

33394          UPDATE NO.: CENV(A)
MONITORING OF HEAVY METALS IN PHILIPPINE RIVERS, BAY WATERS AND
LAKES
LESACA RP
AFFILIATION: NATIONAL POLLUTION CONTROL COMMISSION
INTERNATIONAL CONF ON HEAVY METALS IN THE ENVIRONMENT
002 285-308
PUBLICATION TYPE: 5 Proceedings
REF. SOURCE: 0010501  REF. SOURCE NO.: QH545.H45I57 75
KEYWORDS: HEAVY METALS, PHILIPPINE RIVERS, MINERAL DEPOSITS,
HEAVY METAL POLLUTION, AGNO RIVERS, BUED RIVER, MINE TAILINGS,
AQUATIC ENVIRONMENTS, MERCURY, MERCURY POLLUTION, WATER
POLLUTION, HYDROCARBONS, MERCURY CONTAMINATION
    THIS PAPER IS CONTAINED IN THE 'INTERNATIONAL CONFERENCE ON
HEAVY METALS IN THE ENVIRONMENT, SYMPOSIUM PROCEEDINGS, VOLUME
II, PART 1, TORONTO, ONTARIO, CANADA, OCT. 27-31, 1975'. THE
PHILIPPINES POSSESSES VARIED AREAS OF UNEVENLY DISTRIBUTED
MINERAL DEPOSITS, AND IS CONSIDERED ONE OF THE HIGHLY
MINERALIZED COUNTRIES IN SOUTHEAST ASIA. HEAVY METAL POLLUTION
ORIGINATES FROM MINING COMPANIES, ONE OF THEM ON A VERY RICH
MERCURY DEPOSIT.  COPPER MINING OPERATIONS IN THE COUNTRY ARE
FOUND IN THE BAGUIO AREA WITHIN THE CATCH BASINS OF AGNO AND
BUED RIVERS.  HUGE QUANTITIES OF TAILINGS PRODUCED BY THESE
MINES CAUSE EXCESSIVE SILTATION, AFFECTING THE ECOLOGY OF THE
AQUATIC ENVIRONMENT. THE DISPOSAL OF MINE TAILINGS CAUSES WATER
QUALITY DEGRADATION AS WELL AS AFFECTING AGRICULTURAL AREAS AND
THE FISHING INDUSTRY.  THE GOVERNMENT HAS TAKEN A HAND IN

SOLVING THE PROBLEM AND CREATED AN AD HOC COMMITTEE TO CONDUCT
FEASIBILITY STUDIES ON A SATISFACTORY SYSTEM OF DISPOSAL OF MINE
TAILINGS FROM BAGUIO MINING DISTRICT AND THE TOLEDO MINES. A
SURVEY SHOWED THAT HEAVY METALS CONTRIBUTION OF THESE TAILINGS
TO AGNO RIVER AMOUNTS TO 0.0520 PPM FOR IRON, 0.0250 PPM FOR
ALUMINUM, 0.0170 PPM FOR NICKEL, 0.0070 PPM FOR COPPER AND
0.0001 PPM FOR MERCURY.  19 REF., 9 TAB.

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BANK =      13              - QL SYSTEMS LIMITED -          D=  18295  CEN

33387          UPDATE NO.: CENV(A)
RESPONSE OF LAKE SUPERIOR ALGAE TO NUTRIENTS AND TACONITE
TAILINGS
PLUMB RH, LEE GF
AFFILIATION: INSTITUTE ENVIRONMENTAL SCIENCES, UNIV TEXAS,
DALLAS, TEXAS
JOURNAL WATER POLLUTION CONTROL FEDERATION JWPF-A
1975-03 047 003 619-25
PUBLICATION TYPE: 1 Article
REF. SOURCE: 0010501
RESERVE MINING CO, SILVER BAY, MINN.
KEYWORDS: LAKE SUPERIOR, LAKES, ALGAE, TACONITE, NUTRIENTS,
TAILINGS, PHOSPHATE, NITRATE SILICA, IRON, ORE
    A LABORATORY BIOASSAY WAS CONDUCTED TO DETERMINE THE
RESPONSE OF LAKE SUPERIOR ALGAE TO ADDITIONS OF SUCH NUTRIENTS
SUCH AS PHOSPHATE, NITRATE, AND SILICA AND TO IRON ORE
PROCESSING WASTES (TACONITE TAILINGS) ENTERING THE MINNESOTA
WATERS OF LAKE SUPERIOR.  BASED ON CHANGES IN THE RATE OF CARBON
FIXATION, PHOSPHATE STIMULATED APPROXIMATELY 90 PERCENT OF THE
CULTURES TO WHICH IT WAS ADDED, AND NITRATE AND SILICA WERE
NONSTIMULATING.  THE NATIVE LAKE SUPERIOR ALGAE WERE NOT
STIMULATED BY TACONITE TAILINGS IN MORE THAN 95 PERCENT OF THE
CULTURES RECEIVING THE MINING DISCHARGE.  HOWEVER THE ALGAE DID
RESPOND TO TAILINGS PLUS PHOSPHATE, WHICH INDICATES THAT THESE
TAILINGS ARE NONTOXIC AS WELL AS NONSTIMULATING. 7 REF., 1 TAB., 1
FIG.
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BASE =      14              - QL SYSTEMS LIMITED  -         D=   6060  CEN

8993           UPDATE NO.: CENV(A)
MIGRATION AND LEACHING OF METALS FROM OLD MINE TAILINGS DEPOSITS
GALBRAITH JH, WILLIAMS RE, SIEMS PL
AFFILIATION: UNIV IDAHO, COLL MINES, MOSCOW, IDAHO
GROUND WATER GRWA-A

TECHNICAL DIVISION, NATIONAL WATER WELLS ASSOC LOUISVILLE KY
1972-05 010 003 33-44
PUBLICATION TYPE: 1 Article
REF. SOURCE: 0010501
US BUREAU OF MINES
KEYWORDS: MINE WASTES, TAILINGS, LEACHING, HEAVY METALS,
GROUNDWATER, MICROORGANISMS, SULFUR BACTERIA, IRON BACTERIA,
WATER QUALITY, IDAHO, COEUR D'ALENE RIVER, SAMPLING, CHEMICAL
ANALYSIS, OXIDATION
    LEACHING OF HEAVY METALS BY GROUND WATER PASSING THROUGH
MINE TAILINGS IS CAUSED BY THE OXIDATION OF SULFIDES THROUGH THE
ACTION OF MICROORGANISMS.  THE PH OF THE GROUND WATER ENTERING
THE TAILINGS SYSTEM IS REDUCED BY MECHANISMS WITHIN THE TAILINGS
SYSTEM ITSELF.  FOUR LINES OF EVIDENCE DEMONSTRATE THE PRESENCE
OF MICROORGANISMS IN THE TAILINGS SYSTEM:  (1) FE-MN CONCRETIONS
BELOW THE WATER TABLE AT CATALDO MISSION FLATS,  (2) FIXATION OF
PB AND S BELOW THE WATER TABLE,  (3) PRECIPITATION OF SULFATE
SALTS ON THE SURFACE OF CATALDO MISSION FLATS, AND (4)
EXPERIMENTS ON TWO SETS OF TAILINGS SAMPLES, ONE FROM THE
SURFACE WHICH SHOWED PREDOMINANT AEROBIC ACTIVITY AND ONE FROM
BELOW THE WATER TABLE WHICH SHOWED PREDOMINANT ANAEROBIC
ACTIVITY.  WHERE OXYGEN IS SUFFICIENT, IRON OXIDIZING BACTERIA
FORM AN INSOLUBLE HYDROXIDE.  CONSEQUENTLY, VERY LITTLE IRON IS
FOUND IN THE GROUND WATER COMING FROM THE SYSTEM.  THE
COMBINATION OF THESE MECHANISMS PRODUCES GOOD-QUALITY GROUND
WATER WITH RESPECT TO METALS.

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63688 UPDATE NO.: CENV83(9)
A water quality assessment of Kenogamisis Lake, District of Thunder Bay
Minis Priv Abatement Sect, Northwest Reg, Ont Minist Environ
1982-07 13p 5 ref, 3 fig, 12 tab, 3 app LANG.: En
PUBLICATION TYPE: 3 Report SCL.: CIMEN
REF. SOURCE: 2060210
GEOGRAPHIC ID.: W86 55,N49 42
KEYWORDS: Kenogamisis Lake, Ontario, water quality, water sampling, on-site data collections, arsenic, water analysis, heavy metals, sediments, mine wastes, climatic data

The Ontario Ministry of the Environment conducted a water quality survey of Kenogamisis Lake, District of Thunder Bay, during the first six months of 1981. This followed a preliminary investigation of potential arsenic and cyanide contamination, conducted during the summers of 1979 and 1980. Samples of lake water and domestic drinking water supplies, were collected and analysed to determine if there was any water quality impairment as a result of previous mining activity, and the resultant deposition of tailings in and adjacent to the lake. Iron and manganese levels were found to exceed Ministry drinking water objectives (0.3 and 0.05 mg/L respectively), in the waters adjacent to the tailings deposits. Those waters found to contain elevated metal levels are not being utilized as drinking water supplies. Sampled drinking waters, taken from the lake, all contained traces of arsenic; however, none exceeded the Ministry's drinking water rejection criterion of 0.05 mg/L As. Data collected over the past three years suggest that the arsenic concentration in Kenogamisis Lake has decreased. This, however, may not be the result of a long-term stable reduction, but rather due to overall climatic and hydrogeologic factors. Cyanide was not detected in the waters of Kenogamisis Lake.

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59484 UPDATE NO.: CENV82(7)
Cyanide analysis in mine effluents
CONN F
Cyanide and Gold Mining Ind Semin, Ottawa, Ont, 22-23 Jan 1981
1981 11p 3 app, 4 tab, 4 ref LANG.: En
PUBLICATION TYPE: 4 Conference paper
REF. SOURCE: 0010901 REF. SOURCE NO.: NATDOC
KEYWORDS: mine wastes, effluents, cyanide, chemical analysis, HCN, environmental protection, standards, gold mining

Cyanide in mine effluent could be a combination of cyanide ion, molecular hydrogen cyanide and metallo-cyanide complexes, the rations depending upon pH and cyanide and metal concentrations. Even at pH8, the cyanide ion will associate to form hydrogen cyanide. There is uncertainty as to what to measure to protect the environment. Of the 3 choices, total cyanide is considered meaningless by biologists. Another alternative is molecular hydrogen cyanide and cyanide ion. The third alternative is HCN, CN^-, and in addition the HCN which could be formed from breakdown of cyanide species in the environment. The speaker discusses the methods associated with analysis in these 3 cases. To provide a comparison of differences in methods, a series of tails decant samples from Ontario mines was analyzed for total cyanide, cyanide amenable to chlorination, and weak acid dissociable cyanide. The results do not show large differences, because the sample iron content is low. Where samples contain high levels of copper, there are differences between cyanide amenable to chlorination and weak acid dissociable cyanide. A larger data base is required before any definitive statements can be made about specific requirements for the various forms of cyanide in gold mining wastes.

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53931 UPDATE NO.: CENV82(1)
Environmental quality in the Atlantic provinces 1979
WILSON RCH, EATON PB, HALL SP, STONE HH
AFFILIATION: Environ Can, Environ Prot Serv, Atl Reg
Environ Can, Environ Prot Serv, Atl Reg
1980-05 105p 188 ref, fig, tab LANG.: En
PUBLICATION TYPE: 3 Report
REF. SOURCE: 0010905

KEYWORDS: Atlantic provinces, Nova Scotia, New Brunswick, Newfoundland, Prince Edward Island, environmental effects, environment, ecology, air pollution, pollutants, water pollution sources, mercury, asbestos, fluorides, lead, mine wastes, pulp wastes, pesticides, natural resources, forestry, cadmium, polychlorinated biphenyls, dioxin, energy, electric power production, hydroelectric power, nuclear powerplants, oil fields

This report presents information on a number of aspects of the environment and its problems, from which the reader can infer a level of quality for the environment. It discusses air and water quality, and gives specific data on pollutants such as mercury, asbestos, fluoride, lead, iron-ore tailings, and pulp and paper mill effluent. A chapter on the ecology and the use of resources outlines the effects of forestry practices, forest pests, and agricultural practices. A chapter on toxic substances discusses mercury, polychlorinated biphenyls, cadmium, chlorinated benzenes, dioxins, polynuclear aromatic hydrocarbons, industrial and hazardous wastes, and pesticides. A chapter on energy discusses transportation, energy conservation, electric power generation by coal, peat, tidal nuclear and water power, and the potential offshore oil and gas development.

51061 UPDATE NO.: CENV81(7)
Preliminary assessment of the copper-zinc deposit, Goldstream River area, Revelstoke mining area
Noranda Mines Ltd, Goldstream Div
Noranda Mines Ltd, Goldstream Div, Kamloops, BC
1979-06 125p 2 app, 8 ref, 3 tab, 18 fig LANG.: En
PUBLICATION TYPE: 3 Report
REF. SOURCE: 0011481
GEOGRAPHIC ID.: W118 40-W118 05/N51 38-N51 30
KEYWORDS: British Columbia, Goldstream River, Copper-zinc mines, mine tailings, water quality, environmental impacts, fish resources, heavy metals, suspended solids, dissolved oxygen, benthic invertebrates

This report discusses Noranda Mines proposed copper-zinc mine development in the Big Bend area, approximately 58 kilometres north of Revelstoke. The mine is discussed in terms of its size and daily output, required servicing, and environmental impacts. A lengthy appendix to this report contains environmental baseline data on the water quality and flow parameters of the Goldstream River and on the terrestrial resources in the mine area. The mine will require a permanent workforce of 185 people. Ore will be mined from a small open pit and by underground methods. The mine will produce 1,360 metric tons per day of material of which 544 metric tons will be returned to the mine openings to prevent subsidence, and 600 metric tons will be pumped to a tailings disposal area. The major environmental impact associated with the development is a possible reduction in the water quality of the Goldstream River as a result of effluent from the tailings site. Presently invertebrate populations in the Goldstream River are indicative of clean water conditions. Baseline water quality data exhibited wide variations for many parameters, most notably suspended and dissolved solids, conductivity, sulfate, calcium, alkalinity, total iron, chemical oxygen demand, dissolved oxygen, and temperature. Total zinc ranged from .001 to .030 ppm, and total copper ranged from .001 to .003 ppm. Arsenic and molybdenum levels reached a maximum of .010 ppm, and cadmium reached a maximum at .001 ppm. The number of invertebrate organisms per square metre of river bottom ranged from 304.6 to 372.7 in May to 326.5 to 752.5 in October. The tributaries of the Goldstream River showed a large variation in the numbers and complexity of benthic communities. Brewster Creek was the most productive tributary containing populations of 1089.9 to 1698.5 organisms per square metre with a maximum of 20 taxa per sample.

* * *

RANK = 19 - QL SYSTEMS LIMITED - D= 44310 CEN

50015 UPDATE NO.: CEN781(6)
Highland Valley ecological study, progress report no. 4, phase 1
BC Research
BC Research, 3650 Wesbrook Cres, Vancouver, BC
1971 40p 14 fig, 15 tab LANG.: En
PUBLICATION TYPE: 3 Report
REF. SOURCE: 0011481
NOTES: Report prepared for Lornex Mining Co Ltd
GEOGRAPHIC ID.: W121 05,N50 35
KEYWORDS: British Columbia, Highland Valley, Logan Lake, Quiltanton Lake, Guichon Creek, Pukiast Creek, water quality, Lornex Mining Co, water chemistry, dissolved solids, heavy metals, copper, iron, zinc, coliforms, tailings ponds

This report presents the results of water quality investigations in the Highland Valley prior to mining operations by Lornex Mining Co. Water quality data was obtained in 1970 from creeks and lakes associated with the present and projected mining and milling operations and the townsite. Samples were taken from Pukiast Creek, Woods Creek, Burr Creek, Beaver Lake, Ward Creek, Award Creek, Quiltanton Lake, seepage ponds in the Bethlehem copper area, Trojan Creek, Witches Brook, Highmont Creek, Guichon Creek, Jacks Creek, the townsite well, and Logan Lake. No significant copper concentrations were found in stagnant ponds adjacent to the proposed Lornex Mine pit. Quiltanton Lake showed high organic carbon levels probably related to humus, moderately high nutrients, very low biological oxygen demand, and no faecal coliforms. There was a possibility of leakage into Trojan Creek from the Bethlehem seepage ponds or tailings dam as evidenced by a high level of dissolved solids and a high conductivity. Water from Bethlehem Copper's deep well showed higher values for silicon dioxide, calcium, magnesium, iron, and hardness and lower values for sulphate, chloride, soluble solids, lead, and zinc than that reported for Witches Brook surface waters. Logan Lake is eutrophic with characteristically high nutrients, conductivity, dissolved solids, organic carbon, color, and turbidity. If summertime odors from the lake can be solved with a minimum of disturbance, the lake should be preserved as part of an aesthetic park retaining the beaver and waterfowl. The possibility of fish stocking should be investigated.

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BANK = 20 - CL SYSTEMS LIMITED - D= 43969 CEN

49674 UPDATE NO.: CENV81(5)
Marine environmental assessment of Tasu Sound, British Columbia, June 1977
BROTHERS DE
AFFILIATION: Fish Environ Can, Environ Prot Serv, Environ Prot Branch, Pac Reg
Reg Program Rep 78-12
Fish Environ Can, Environ Prot Branch, Environ Prot Serv, Pac Reg
1978-06 33p 13 fig, 12 tab LANG.: En
PUBLICATION TYPE: 3 Report
REF. SOURCE: 0011481
GEOGRAPHIC ID.: W132 00,N52 50
KEYWORDS: British Columbia, Queen Charlotte Islands, Wesfrob Mines, mine wastes, tailings, iron, copper, zinc, water pollution, benthos, heavy metals, marine animals, marine plants, phytoplankton, outfall, Inskip channel, Fucus, shrimp, flatfish, mussels

In June, 1977, the Environmental Protection Service conducted an environmental survey to assess the effects of the unconfined discharge of mill tailings from Wesfrob Mines Limited into Tasu Sound, Queen Charlotte Islands, British Columbia. Tailings from the 6000 dry metric tons per day iron-copper dressing plant have been discharged directly to Tasu Sound since 1967. The survey program included: water column transmissibility profiles; phytoplankton productivity measurements; sediment and fauna sampling and analyses for heavy metals; deep benthic trawling; and an examination of the intertidal zone in the proximity of the outfall. This report presents the results of the survey and conclusions based upon these results.

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BANK = 21 - CL SYSTEMS LIMITED - D= 43740 CEN

49445 UPDATE NO.: CENV81(5)
Water quality and biological surveys in the Highland Valley, B.C. May 1977 to April 1978
DWERNYCHUK LK, CREBAR JA
AFFILIATION: Beak Consultants Ltd
Beak Consultants Ltd, suite 602/1550 Alberni St, Vancouver BC V6G 1A5
1978-05 100p 12 fig, 31 tab, 35 ref, 2 map LANG.: En
PUBLICATION TYPE: 3 Report
REF. SOURCE: 0011481
NOTES: Report prepared for Lornex Mining Co Ltd, Highland Valley,BC
GEOGRAPHIC ID.: W121 05,N50 35
KEYWORDS: British Columbia, Highland Valley, Lornex Mines, water quality, benthic organisms, water chemistry, heavy metals, fish tissue analysis, cyanide, copper, iron, zinc, molybdenum, trace metals

This report presents the results of chemical and biological analyses of water courses that may be affected by the Lornex mine and mill operations. Studies are conducted yearly through a systematic water sampling system beginning in 1971. The project came into operation in summer, 1972. Chemical analyses are taken in the spring and fall, while since 1976 biological analyses are taken only in the fall. The tailings pond supernatant displayed reduced levels of pH, copper, arsenic, and total cyanide in comparison with the 1976-77 survey, though there was a slight increase in iron and zinc levels. Increasing trends in mean concentrations of molybdenum and dissolved solids were observed in the tailings pond supernatant the groundwater form the J-J monitor well, and form Pukaist Creek. However Award and Trojan Creeks showed a decrease in mean molybdenum concentrations. The construction of a new dam eliminated flow in the lower Pukiast. As a result there is no biological data available for this station. Biolgoical studies showed no overall detrimental impact on benthic communities inhabiting Quiltanton Lake, Upper Guichon Creek, and Witches Brook. Trace metal analyses of fish tissue indicated values below the levels set by the Canadian Food and Drug Directorate. Values for iron and zinc were greater in 1977 compared to 1976 in both Woods Creek and Upper Pukaist.

BANK = 22 - QL SYSTEMS LIMITED - D= 43738 CEN

49483 UPDATE NO.: CENV81(5)

Water quality and biological surveys in the Highland Valley, B.C. May 1976 to April 1977

Beak Consultants Ltd

AFFILIATION: CHERNYCHUK IW, NICHOL JM

Beak Consultants Ltd, suite 602/1550 Alberni St, Vancouver, BC
V6G 1A5

1977-07-25 100p 35 ref, 7 fig, 17 tab LANG.: En

PUBLICATION TYPE: 3 Report

REF. SOURCE: 0011481

NOTES: Report prepared for Lornex Mining Co Ltd, Highland Valley, BC

GEOGRAPHIC ID.: W121 05,N50 35

KEYWORDS: British Columbia, Highland Valley, Lornex Mines, water quality, water chemistry, benthic organisms, heavy metals, tissue analysis, cyanide, copper, iron, arsenic, zonc, molybdenum

This report presents the results of chemical and biological analyses of water courses that may be affected by the Lornex mine and mill operations. Studies are conducted twice yearly through a systematic water sampling system. Pre-operational studies were performed in 1971 and 1972. As of this year the Spring biological survey has been discontinued. Therefore this report presents only the biological results for the Fall sampling period. Chemical water quality studies are presented for both the spring and fall. Chemical analyses showed that reclaim water from tailings displayed noticeably reduced levels of pH, copper, iron, arsenic, zinc, and total cyanide in comparison with the 1975 survey. The water quality characteristics of nearby watersheds showed very little variation from preceeding years. However increasing trends in mean concentrations of molybdenum and/or dissolved solids were observed in certain water systems in the area. Biological studies showed that the benthic community structure was indicative of undisturbed systems. Differences observed between sample locations were attributed primarily to inherent biological variability rather than to factors outside of the freshwater systems. Trace metal concentrations in fish tissue were below the levels set by the Canadian Food and Drug Directorate.

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RANK = 23 - CL SYSTEMS LIMITED - D= 43737 CEN

49442 UPDATE NO.: CENV81(5)
Water quality in the Highland Valley, British Columbia June 1978 to March 1979
Beak Consultants Ltd
Beak Consultants Ltd, 3851 Shell Rd, Richmond, BC V6X 2W2
1979-06 50p 33 tab, 7 fig LANG.: En
PUBLICATION TYPE: 3 Report
REF. SOURCE: 0011481
NOTES: Report preapred for Lornex Mines Co Ltd, Highland Valley BC
GEOGRAPHIC ID.: W121 05,N50 35
KEYWORDS: British Columbia, Highland Valley, Lornex Mines, water quality, water chemistry, cyanide, copper, iron, zinc, molybdenum, trace metals

This report presents the results of chemical analyses of water courses that may be affected by the Lornex mine and mill operations. Studies are conducted yearly through a systematic water sampling system begun in 1971. The mine began operations in the summer of 1972. The stations monitored include effluent streams from the tailings pond, the Pukaist Creek watershed, the Witches brook watershed, and the Guichon Creek watershed. Survey results for this year show a continuing reduction in the concentrations of arsenic and total cyanide in the effluent streams. Copper, zinc and iron concentrations increased slightly since 1977-1978. Molybdenum concentrations are well below those of 1977-1978. The water quality of Guichon Creek was not adversely affected by the Logan Lake sewage effluent during the survey period. The Pukaist Creek mean metal and total cyanide concentrations are similar to those of Woods Creek, which is not affected by the mine. There is no noteworthy variation in the metal and cyanide concentrations in the Witches brook watershed.

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BANK = 24 - CL SYSTEMS LIMITED - D= 43736 CEN

49441 UPDATE NO.: CENV81(5)
Water quality in the Highland Valley, B.C. June 1979 to March 1980
Beak Consultants Ltd
Beak Consultants Ltd, suite 602/1550 Alberni St, Vancouver, BC V6G 1A5
1980-05 50p 4 ref, 20 tab, 7 fig, 1 map LANG.: En
PUBLICATION TYPE: 3 Report
REF. SOURCE: 0011481
NOTES: Report prepared for Lornex Mines Ltd, Highland Valley, BC
GEOGRAPHIC ID.: W121 05,N50 35
KEYWORDS: British Columbia, Highland Valley, Lornex Mines, water quality, water chemistry, cyanide, copper, iron, zinc, molybdenum, groundwater

This report presents the results of chemical studies on the water courses that may be affected by the Lornex mine and mill operations. Studies are conducted yearly through a systematic water sampling system begun in 1971. The mine began operations in summer, 1972. Copper, iron, and cyanide concentrations in the tailings impoundment supernatant showed a marked increase from the previous year, molybdenum showed a decrease, and arsenic and zinc levels were essentially unchanged. Groundwater taken from the monitoring wells continued to meet Pollution Control Board level A objectives for effluent concentrations except for iron in the monitor well near the I-L dam.

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BANK = 25 - CL SYSTEMS LIMITED - D= 43738 CEN

49439 UPDATE NO.: CENV81(5)
Water quality and biological surveys in the Highland Valley, B.C. May 1975 - April 1976
DREHR CHUK LS, NICKEL JR
AFFILIATION: Beak Consultants Ltd
Beak Consultants Ltd, 385-A Shell Rd, Richmond, BC V6X 2W2
1976-06 60p 39 tab, 14 fig LANG.: En
PUBLICATION TYPE: 3 Report
REF. SOURCE: 0011481
NOTES: Report prepared for Lornex Mining Co Ltd, Highland Valley, BC
GEOGRAPHIC ID.: W121 05,N50 35
KEYWORDS: British Columbia, Highland Valley, Lornex Mines Co, water quality, water chemistry, trace metals, benthic communities, fish tissue analysis, molybdenum, arsenic, copper, iron, zinc, cyanide, water pollution

This report presents the results of chemical and biological analyses of water courses that may be affected by the Lornex mine and mill operations in the Highland Valley. The report covers the spring and fall sampling periods of 1975. Sampling began initially in 1971 and has been continued on a twice yearly basis since then. The mine began operations in May, 1972. Tailings and reclaimed water displayed reduced levels of copper, iron, arsenic, zinc, and total cyanide, resembling concentrations found during the first year of operations, but an increase in mean molybdenum was noted. Pukiast creek continued to be similar to the control station characteristics. Trace metal concentrations in fish tissues sampled from Pukiast Creek were significantly lower than the levels set by the Canadian Food and Drug Directorate as being safe. There was no evidence to suggest that metallic iron was concentrating in trout tissue at an excessive rate. An examination of the data from the present survey and from preceeding years indicated that the Lornex operation was not exerting a negative effect on the structure and composition of benthic communities in the area. Changes in these communities must be due other forces. The Logan Lake sewage treatment plant has had no adverse effects on the water quality of Guichon Creek.

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BANK = 26 - CL SYSTEMS LIMITED - D= 41519 CEN

A722A UPDATE NO.: CENV81(8)

An ecological perspective of reclamation

BOYER EN, SICHNER PA, SHETRON SG

AFFILIATION: Cleveland-Cliffs Iron Co, Ishpeming, MI, US

Canadian Land Reclamation Association, Proc of the Third Annual
Meeting, Laurentian Univ, Sudbury, Ont, 29 May - 1 June, 1978
Can Land Reclam Assoc, Guelph, Ont ISSN 0705-5927
1978 121-132 31 ref, 2 fig LANG.: En
PUBLICATION TYPE: 4 Conference paper
REF. SOURCE: 0010501
KEYWORDS: North America, mining industries, mineral processing,
land reclamation, management, ecosystems, soils, vegetation,
vertebrate community, Humboldt Mine, Michigan, wildlife

Mining and associated mineral processing can cause major alterations of land form and ecosystem structure and function. Following mining, use of an area is frequently limited owing to low biological productivity. Since areas which produce biological products, e.g., food, fiber, and wildlife, are ecosystems, the goal of reclamation should be the development of ecosystems. Successful establishment of an ecosystem will ensure that maintenance will not be needed to keep a vegetative cover or renew it if further disturbed, such as a fire. Success in achieving reclamation goals should be evaluated on the basis of ecological criteria, stability with reference to erosion and aesthetic appeal. The evaluation would include monitoring rate of soil formation, changes in nutrient status, and the growth of vegetation. Performance of the vertebrate community inhabiting the site would give a further measure of productivity. Several specific measurement criteria are discussed. It is important that any land use following mining not impede the recovery process. Recent studies have shown that development of the site for wildlife could be accomplished within this constraint. Management could emphasize the total community or selected species. In the former case, no single fauna species would be assigned a higher priority than any other, while in the latter case, the aim of management would be to benefit a particular species or group of species. Principles for implementing community management are given. As an example of emphasizing one species in wildlife management, goose pastures could be developed on the iron ore tailings basins.

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35737          UPDATE NO.: CENV(A)
CHRONIC TOXICITY OF WATER-BORNE AND DIETARY LEAD TO RAINBOW
TROUT (SALMO GAIRDNERI) IN LAKE ONTARIO WATER
HODSON PV, BLUNT BR, SPRY DJ
AFFILIATION: GREAT LAKES BIOLIMNOLOGY LAB, CCIW, BURLINGTON,
ONTARIO
WATER RESEARCH WATR-A
1978 012 010 869-878
PUBLICATION TYPE: 1 Article
REF. SOURCE: 0[illegible]10501
KEYWORDS: LAKE ONTARIO, LEAD CONCENTRATIONS, RAINBOW TROUT,
MEASUREMENTS, TESTS, FISH, WATER QUALITY, LEAD EXPOSURE,
SAMPLING, PHYSIOLOGICAL METHODS, BLOOD, CELLS, EXPERIMENTAL
DIETS, SEASONAL VARIATIONS, EXPOSURE, EFFECTS, SPINAL
DEFORMITIES, FISH DISEASES, HEAVY METALS
    RAINBOW TROUT (SALMO GAIRDNERI) EXPOSED TO LEAD IN LAKE
ONTARIO WATER DEMONSTRATED A 21 DAY LC SUB 50 OF 2.4 MG PER L
LEAD.  AT LEAD CONCENTRATIONS RANGING FROM 3 TO 120 MICRO G PER
L, LOG SUB 10 OF LEAD CONCENTRATIONS IN MOST TISSUES OF EXPOSED
FISH APPEARED LINEARLY RELATED TO LOG SUB 10 OF LEAD
CONCENTRATIONS IN WATER.  HIGHEST CONCENTRATIONS OCCURRED IN
OPERCULAR BONE FOLLOWED BY GILL AND KIDNEY.  LEAD ACCUMULATION
BY BRAIN WAS NOT CLEARLY DEMONSTRATED. EXPOSURE TO LEAD IN WATER
AT CONCENTRATIONS AS LOW AS 13 MICRO G PER L CAUSED SIGNIFICANT
INCREASES IN RED BLOOD CELL (RBC) NUMBERS, DECREASES IN RBC
VOLUMES, DECREASES IN RBC CELLULAR IRON CONTENT AND DECREASES IN
RBC DELTA-AMINO LEVULINIC ACID DEHYDRATASE ACTIVITY.  NO CHANGES
WERE OBSERVED IN HEMATOCRIT OR WHOLE BLOOD IRON CONTENT.  THE
CHANGES INDICATED INCREASED ERYTHROPOIESIS TO COMPENSATE FOR
INHIBITION OF HEMOGLOBIN PRODUCTION AND INCREASED MORTALITY OF
MATURE RED BLOOD CELLS.  AFTER 32 WEEKS EXPOSURE TO 120 MICRO G
PER L LEAD IN WATER, 30% OF REMAINING FISH EXHIBITED BLACK
TAILS, AN EARLY INDICATION OF SPINAL DEFORMITIES.  LEAD ADDED TO
FOOD WAS NOT AVAILABLE FOR LEAD UPTAKE BY FISH.  LEAD CONTENT OF
FISH EXPOSED TO DIETARY LEAD WAS NOT ELEVATED ABOVE CONTROL
LEVELS AND THE MAJORITY OF LEAD CONSUMED COULD BE ACCOUNTED FOR
IN THE FAECES.  DIETARY LEAD MAY HAVE SLIGHTLY INHIBITED UPTAKE
OF DIETARY IRON.  30 REF, 7 FIG, 2 TAB.

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BANK = 28 - QL SYSTEMS LIMITED - D= 29453 CEN

35049 UPDATE NO.: CENV(A)
WATER QUALITY AND BIOLOGICAL SURVEY AT ARCTIC GOLD AND SILVER MINES LTD., YUKON TERRITORY, SUMMER, 1975
WEAGLE K, ROBSON W, GOLLER K
AFFILIATION: EPS, WHITEHORSE, YUKON TERRITORY
SURVEILLANCE REPORT

ENVIR CANADA, EPS, PACIFIC REGION VANCOUVER, BC PUBLISHER NO.:
EPS 5-PR-76-10
1976-05 18 P
PUBLICATION TYPE: 3 Report
REF. SOURCE: 0010906
KEYWORDS: TANK CREEK, WATER CHEMISTRY, FAUNA, MINES, BENNETT LAKE, MERCURY, MILLS, TAILINGS, SULPHIDES, FISH, METALS, LABORATORIES, FIELDS, INVERTEBRATES, DIVERSITY, EVENNESS, DISSOLVED OXYGEN, YUKON

BIOLOGICAL AND WATER CHEMISTRY DATA WERE COLLECTED FROM THE TANK CREEK WATERSHED NEAR THE ABANDONED ARCTIC GOLD AND SILVER MINES LTD. MILL SITE DURING THE SUMMER OF 1975. PHYSICAL AND CHEMICAL PARAMETERS MEASURED AND THE BIOLOGICAL COMMUNITIES SAMPLED PRODUCED LITTLE EVIDENCE THAT THE ABANDONED MILL SITE HAS HAD AN ADVERSE EFFECT ON THE WATERSHED OF TANK CREEK. SPRING RUNOFF FROM THE MILL SITE APPEARED TO HAVE INCREASED THE EXTRACTABLE IRON AND ARSENIC LEVELS AND THE DISSOLVED SULPHATE LEVELS IN TANK CREEK. A POSSIBLE ANOMALY IN THE DISTRIBUTION OF MERCURY IN THE STUDY AREA WAS ENCOUNTERED. HOWEVER, THESE INCREASES WERE NOT GREAT ENOUGH TO AFFECT THE BIOLOGICAL COMMUNITIES. THE MILL SITE APPEARED TO HAVE NO EFFECT ON BENNETT LAKE. 7 REF, 2 FIG, 5 TAB.

BANK = 29 - QL SYSTEMS LIMITED - D= 29441 CEN

35036 UPDATE NO.: CENV(A)
THE IRON ORE INDUSTRY OF WESTERN LABRADOR AND SOME EFFECTS OF ITS WASTE DISPOSAL PRACTICES ON THE AQUATIC ENVIRONMENT
HICKS BJ
SURVEILLANCE REPORT
ENVIRONMENT CANADA, EPS, ATLANTIC REGION ST. JOHN'S, NFLD
PUBLISHER NO.: EPS-5-AR-74-2
1974-01 128 P
PUBLICATION TYPE: 3 Report
REF. SOURCE: 0010905
KEYWORDS: IRON MINING INDUSTRY, WESTERN LABRADOR, GEOLOGY, MINING, CRUSHING, GRINDING, ORE CONCENTRATION, MAGNETIC PLANTS, PELLETIZING PLANTS, CHEMICAL FLOTATION, WABUSH-SCULLY MINES, MILLING, WASTE EFFLUENTS, DISPOSAL SITES, SEDIMENTOLOGY, FISHERY, WATER CHEMISTRY, BENTHIC FAUNA, PLANKTON, MANGANESE, TOXICITY

THE REPORT DESCRIBES MINING AND MILLING PRACTICES CURRENTLY IN USE BY MINES OPERATING IN WESTERN LABRADOR, AND THE EFFECTS OF TAILINGS DISPOSAL ON THE WATER QUALITY AND BIOLOGY OF WABUSH LAKE. REFERENCE IS MADE TO EARLIER TOXICITY, SEDIMENTOLOGICAL AND WATER QUALITY STUDIES OF WABUSH LAKE THAT WERE CARRIED OUT BY VARIOUS GOVERNMENTAL AGENCIES IN 1965 AND 1966. RESULTS ARE COMPARED TO FINDINGS OF THESE STUDIES TO DOCUMENT CHANGES. IN ADDITION, AGE AND GROWTH OF LAKE WHITEFISH, BENTHIC MACROINVERTEBRATES, AND PRIMARY PRODUCTIVITY WERE ALSO

INVESTIGATED AS PART OF THE STUDY. IN GENERAL, THE ACTION OF THE TAILINGS ON THE BIOLOGY OF THE LAKE WAS FOUND TO BE SUBTLE OR INDIRECT IN EFFECT, TENDING TO LOWER THE OVERALL PRODUCTIVITY OF THE LAKE. 40 REF, 3 APP, 14 FIG, 1 TAB.

BANK = 30 - CL SYSTEMS LIMITED - D= 29333 CEN

34925 UPDATE NO.: CENV(A)
MINERAL WASTE RESOURCES OF CANADA
COLLINGS RK
AFFILIATION: IND MINERAL LAB, CANMET, DEPT ENERGY, MINES
RESOURCES, OTTAWA
CIM BULLETIN CMBE-A
1978-10 C71 798 80-86
PUBLICATION TYPE: 1 Article
REF. SOURCE: 0010501
KEYWORDS: ENVIRONMENTAL CONTROL, INDUSTRIAL MINERALS, MINERAL WASTES, WASTE RESOURCES, TAILINGS, SLAG, ASH, SLUDGE, BASE METALS, IRON ORE, PRECIOUS METALS, ENERGY MINERALS, CHEMICAL INDUSTRY WASTES, CANADA, GYPSUM, RED MUD, PONDS, CANMET

THE ANNUAL PRODUCTION OF MINERAL AND MINERAL BASED WASTES IN CANADA IS CONSERVATIVELY ESTIMATED TO BE 400 MILLION TONS. OVER 90 PER CENT OF THIS AMOUNT IS WASTE ROCK OR MILL TAILINGS FROM THE MINING AND MINERAL PROCESSING INDUSTRY. THE REMAINDER ARE SLAGS AND ASHES FROM THE METALLURGICAL INDUSTRY, AND SLUDGES FROM THE CHEMICAL INDUSTRY. BECAUSE OF IMPURITY CONTENT, REMOTE LOCATION, OR BOTH, MOST WASTES HAVE LIMITED USEFULNESS AND, INDEED, ARE A LIABILITY IN THAT THEY MUST BE TRANSPORTED TO WASTE DISPOSAL SITES AND CONTAINED THEREIN. CERTAIN MINERAL WASTES DO, HOWEVER, HAVE POTENTIAL VALUE. SOME CONTAIN SMALL PERCENTAGES OF METALS THAT MAY BE ECONOMICALLY RECOVERABLE WITH PRICE INCREASES; OTHER CONSIST OF MINERAL MATERIAL THAT MAY BE USED FOR SUCH PURPOSES AS ROAD BASE, CONSTRUCTION AGGREGATE, RAILROAD BALLAST, AND IN THE MANUFACTURE OF BRICKS OR BLOCKS. INCREASED INTEREST HAS BEEN SHOWN IN MINERAL WASTES IN RECENT YEARS. THIS PAPER REVIEWS THE TYPES OF MINERAL WASTES AVAILABLE IN CANADA, BRIEFLY DESCRIBES A NUMBER THAT HAVE POTENTIAL VALUE, AND NOTES POSSIBLE USES AND RELATED RESEARCH BY CANMET AND OTHER ORGANIZATIONS. 30 REF, 1 TAB.

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BANK = 31 - CL SYSTEMS LIMITED - D= 21875 CEN

27179 UPDATE NO.: CENV(A)
COPPER AND ZINC LEVELS IN SUBMERGED MINE TAILINGS AT BRITANNIA

BEACH, BC
THOMPSON JAJ, MCCOMAS FT
AFFILIATION: PACIFIC ENVIRONMENT INSTITUTE, WEST VANCOUVER, BC
TECHNICAL REPORT NO 437
ENVIRONMENT CANADA, FISHERIES AND MARINE SERVICE, OTTAWA, CANADA
1974-01 33P
PUBLICATION TYPE: 3 Report
REF. SOURCE: 0011103 REF. SOURCE NO.: 27179
KEYWORDS: BRITANNIA BEACH, BRITISH COLUMBIA, MINES, TAILINGS, MINERALS, COPPER, ZINC, CONCENTRATIONS, SAMPLINGS, SEDIMENTS, IRON, ABSORPTION, ANALYSES, PLUME, SEAWATER, HEAVY METALS.

A STUDY OF ACID LEACHABLE COPPER, ZINC AND IRON CONCENTRATIONS IN SUBMERGED MINE TAILINGS HAS BEEN MADE AT BRITANNIA BEACH, BRITISH COLUMBIA. CONCENTRATIONS RANGES OF COPPER AND ZINC WERE 83 TO 1394 AND 97 TO 1324 MICROG /G RESPECTIVELY FOR THE 44 STATIONS SAMPLED. USING COPPER ZINC RATIOS, DISTRIBUTION CONTOURS FOR THE STUDY AREA WERE PLOTTED. IRON ANALYSIS FOR THE SELECTED SAMPLES SHOWED CONCENTRATIONS RANGING FROM 3.9 TO 16.9 PERCENT.

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RANK =     32               -  CL SYSTEMS LIMITED  -          D=  19616  CEN

24595          UPDATE NO.: CENV(A)
CHEMICAL DELINEATION OF A SUBMERGED MINE TAILINGS PLUME IN
RUPERT AND HOLBERG INLETS, BRITISH COLUMBIA
THOMPSON JAJ, PATON DW
AFFILIATION: PACIFIC ENVIRONMENT INSTITUTE, WEST VANCOUVER, BC
TECHNICAL REPORT NO 506
ENVIRONMENT CANADA, FISHERIES AND MARINE SERVICE, WEST
VANCOUVER, BC
1975 22 P
PUBLICATION TYPE: 3 Report
REF. SOURCE: 0010501
KEYWORDS: MINE WASTES, MINE TAILINGS, BRITISH COLUMBIA,
VANCOUVER ISLAND, RUPERT INLET, HOLBERG INLET, MINE ACIDS,
COPPER, ZINC, IRON, WATER POLLUTION SOURCES, LEACHING
    GRAB SAMPLES OF SEDIMENT FROM 43 STATIONS IN RUPERT INLET,
HOLBERG INLET AND QUATSINO SOUND, VANCOUVER ISLAND, B. C. WERE
ANALYSED FOR TOTAL ACID, LEACHABLE COPPER, ZINC AND IRON.  MEAN
CONCENTRATIONS (RANGES IN PARENTHESES) WERE CU, 307 MICROGRAM
PER G (26.5 TO 681); ZN, 83 MICROGRAM PER G (55 TO 120) ; FE,
41.9 MG PER G (30.0 TO 63.6).  HIGHEST CU AND ZN CONCENTRATIONS
WERE FOUND IN RUPERT INLET NEAR THE POINT OF DISCHARGE FROM A
COPPER MOLYBDENUM OPEN PIT MINE.  IN RUPERT INLET, COPPER
CONCENTRATIONS WERE FOUND TO HAVE A DIRECT LINEAR RELATIONSHIP
WITH DEPTH OF THE SAMPLE.  COPPER AND ZINC CONCENTRATIONS AND
THE CU TO ZN RATIO WERE USED TO VERIFY VISUAL IDENTIFICATION OF
THE EXTENT OF ADVANCE OF THE TAILINGS PLUME INTO HOLBERG INLET.
8 FIG, 2 TAB, 9 REF.

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RANK =     33               -  CL SYSTEMS LIMITED  -          D=  17509  CEN

22210          UPDATE NO.: CENV(A)
RESERVE'S LAKE
CARLSON KT
AFFILIATION: SAVE LAKE SUPERIOR ASSOCIATION
ENVIRONMENT ENVT-A
ST LOUIS, MISSOURI
1975-03 V17 N02 16-20, 25, 26
PUBLICATION TYPE: 1 Article
REF. SOURCE: 0010501
KEYWORDS: WATER POLLUTION, LAKE SUPERIOR, RESERVE MINING
COMPANY, INDUSTRIAL WASTES, TAILINGS, LEGAL ASPECTS,
GOVERNMENTS, PUBLIC CONCERN, WATER POLLUTION ABATEMENT,
ASBESTOS, PUBLIC HEALTH, DOMESTIC WATER, WASTE DISPOSAL,
JUDICIAL DECISIONS, LEGISLATION
    THIS ARTICLE PORTRAYS THE FRUSTRATIONS CITIZENS FACE IN
SEEING THAT ANTI POLLUTION LAWS ARE ENFORCED TO HALT DISCHARGE
OF IRON ORE WASTES INTO LAKE SUPERIOR.  THE CONTROVERSY REVOLVES
AROUND THE RESERVE MINING COMPANY OF SILVER BAY, MINNESOTA WHICH
THROUGH PERMISSION OF THE UNITED STATES SUPREME COURT CONTINUES
TO DUMP 750 MILLION GALLONS OF WASTEWATER, CONTAINING 67,000
TONS OF TACONITE WASTE AND 60,000 POUNDS OF DISSOLVED SOLIDS,
INTO LAKE SUPERIOR DAILY.  A BRIEF LEGAL HISTORY, SINCE 1947, OF
RESERVE MINING IS PRESENTED ALONG WITH THE ACTION STIMULATED
FROM THE SAVE LAKE SUPERIOR ASSOCIATION AND OTHER ANTI POLLUTION
ORGANIZATIONS.  RECENTLY (DECEMBER, 1972) IT HAS BEEN SUGGESTED
THAT THERE COULD BE ASBESTOS, A CANCER CAUSING AGENT, IN
RESERVE'S TAILINGS. COURT ACTION WHICH HAS TAKEN PLACE SINCE
1972 IS PRESENTED.
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RANK = 34 - CL SYSTEMS LIMITED - D= 15507 CEN

19855 UPDATE NO.: CENV(A)
TOXIC METAL SPILL PREVENTION IN SULFIDE ORE PROCESSING
MAGORIAN TR
AFFILIATION: ECOLOGY AND ENVIRONMENT, INC, BUFFALO, NEW YORK
PROC 1974 NATIONAL CONF ON CONTROL OF HAZARDOUS MATERIAL SPILLS
AMERICAN INSTITUTE OF CHEMICAL ENGINEERS NEW YORK NY
1974-08 135-39
PUBLICATION TYPE: 3 Report
REF. SOURCE: 0010903
KEYWORDS: TOXIC METALS, THALLIUM, ACID MINE WASTES, SULFIDE ORE PROCESSING, TAILINGS, LEACHING, POLLUTION CONTROL, SLAG HEAPS, SAMPLING, TOXICITY, AQUATIC ENVIRONMENT, FOOD CHAINS, MAGNIFICATION, LETHAL LEVELS, BIOASSAY, BIOCONCENTRATION, WASTE WATER TREATMENT POLLUTION ABATEMENT, STACK GASES

THIS PAPER PRESENTS THE RESULTS OF A STUDY OF THE POLLUTION POTENTIAL OF THALLIUM, A BY-PRODUCT OF SULFIDE ORE PROCESSING AND OTHER METAL REFINING PROCESSES. LEACHING FROM SLAG HEAPS AND MINE TAILINGS IS A MAJOR SOURCE OF THALLIUM POLLUTION. EXAMINATION OF THE EFFECTS ON THE AQUATIC ENVIRONMENT, HOWEVER, INDICATES THAT MOST OF THE THALLIUM CONCENTRATES IN THE SEDIMENTS AND THAT LITTLE BIOCONCENTRATION OCCURS. HIGH LEVELS OF THE METAL ARE TOXIC TO AQUATIC LIFE AND PRECIPITATION FROM STACK GASES SHOULD BE USED. REUSE OF PROCESSING WATER AND TREATMENT OF WASTE WATER ARE ALSO URGED. RESULTS OF A SURVEY OF SELECTED SITES ACROSS THE UNITED STATES ARE SUMMARIZED. 6 REF 2 TABLES

RANK = 35 - CL SYSTEMS LIMITED - D= 8758 CEN

12060 UPDATE NO.: CENV(A)
HYDROLOGICAL-METAL POLLUTION STUDY, HEATH STEELE MINES AREA, NEW BRUNSWICK, CANADA
CHARRON JE
AFFILIATION: INLAND WATERS BRANCH, DEPT ENVIRONMENT, OTTAWA, ONT
TECHNICAL BULLETIN NO 43
ENVIRONMENT CANADA, INLAND WATERS DIRECTORATE OTTAWA ONT
1972 01-47
PUBLICATION TYPE: 3 Report
REF. SOURCE: 0010102 REF. SOURCE NO.: 12060
KEYWORDS: NEW BRUNSWICK, HEATH STEELE MINES, METALS, MINING, WATER POLLUTION SOURCES, ZINC, COPPER, TOMOGONOPS RIVER, MIRAMICHI RIVER, SAMPLING, MINE WATER, PATH OF POLLUTANTS, WATER POLLUTION CONTROL, HYDROGEOLOGY

TWO STREAMS IN THE HEATH STEELE MINES AREA OF NEW BRUNSWICK WERE DETERMINED TO BE AFFECTED BY METAL POLLUTION (ZN AND CU). THESE STREAMS AND THE SPRINGS OF THE AREA ARE NOT POLLUTED IN THEIR NATURAL ENVIRONMENT BECAUSE THE SULPHIDE ORE IN ITS NATURAL UNBROKEN STATE WAS UNOXIDIZED AND, THEREFORE, INSOLUBLE. THE PH OF THESE NATURAL WATERS RANGED FROM 6.0 TO 8.0 WHILE THE VALUE OF TOTAL DISSOLVED SOLIDS WAS LOW AS INDICATED BY SPECIFIC CONDUCTANCE VALUES OF LESS THAN 100 MICROMHOS/CM. THEREFORE, THE METAL POLLUTION IN THE NORTHWEST MIRAMICHI MUST BE CAUSED BY THE HEATH STEELE MINING OPERATION AT THE HEAD OF THE TOMOGONOPS RIVER BASIN. ON THE MINING PROPERTY, THE EXTREME VALUES OBTAINED FOR PH, SPECIFIC CONDUCTANCE AND COPPER WERE 5.0 3,650 MICROMHOS/CM AND 72.0 PPM. METAL POLLUTION WAS SEEN TO INCREASE APPRECIABLY AFTER HEAVY PRECIPITATION, DUE MAINLY TO THE LACK OF FACILITIES FOR TRANSMITTING THESE POLLUTED WATERS TO THE TAILING POND. IF THE CAPACITY OF PUMPING AND TRANSMITTING FACILITIES OR THE STORAGE CAPACITY WERE INCREASED IMMEDIATELY, METAL POLLUTION RESULTING FROM HEAVY PRECIPITATION COULD BE REDUCED BY 85 PERCENT. MAPS SHOW SAMPLE LOCATIONS, POLLUTION CONTROL FACILITIES AND POLLUTION SOURCES.

O

APPENDIX O

MINING TECHNOLOGY (MNT) DATABASE

SEARCH #1 OF 2

SEARCH STRATEGY:

[DRAINAGE OR WATER(S) OR WASTE(S) OR WASTEWATER(S)]

AND

[BACTERIA? OR THIOBACIL?]

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RANK =      1           - QL SYSTEMS LIMITED -        D= 13027  MNT

Publication Date - 720000
Author(S) - Hawley JR
Title - The Problem of Acid Mine Drainage in the  Province of
Ontario.
Citation - Ontario Water Resources Commission, Div. of
Industrial Wastes, 1972, 338 p. (Ref).
Accession Number - (CANMET) MMG6705
Accession Date - 800507
Keywords - 1972, acids, drainage, ontario, minerals, chemicals,
tailings, chemical analysis, water  pollution, oxidation,
neutralization, control, seepage, vegetative stabilization,
dikes + dams, sealing, bibliographies, sulphur, cat 08.
Abstract - The problem of acid mine drainage is  common to the
sulphide mines in Ontario,  and the factors that contribute to
it are various.  The drainage problems are the result of
decomposition of the iron minerals pyrite, pyrrhotite, and
marcasite. The problem continues long  after the mine is closed,
and conventional  mine-mill waste treatments cannot by
themselves  achieve a product that can be discharged into a
natural watercourse. Three waste treatments of acid  mine
drainage that should be considered are: mine-mill wastewater
reuse, gangue sulphide recovery, and  revegetation of abandoned
or unused areas.

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RANK =      2           - QL SYSTEMS LIMITED -        D= 18394  MNT

Publication Date - 750000
Author(S) - Smith JF
Title - Eagle Mine Wastewater Control.
Citation - Water Quality Management for the Metals and Minerals
Industry, short course in conjunction with 104th Annual Meeting
of AIME, New York, 1975, 142p, American Institute of Mining,
Metallurgical and Petroleum Engineers, paper 9p.
Accession Number - (CANMET) MMG21574
Accession Date - 801229
Keywords - cat 08, 1975, united states, zinc mines + mining,
quality control, management, minerals, water, waste disposal,
water pollution, acids, drainage, neutralization, water
treatment.
Abstract - Water treatment for a zinc mine in the Rocky
Mountains in Colorado is described being mainly acid drainage
and heavy metal contamination. The discharge waters from the
ponds contain high levels of pyrite in conjuction with
manganese leading in turn to high levels of zinc, iron and

manganese. A description is given of the use of neutralization
with lime to give a pH above 9 and reducing the zinc below 1
ppm, iron below 2 ppm, and manganese below 2.5 ppm. A lab.
demonstration showed that crushed pyrolusite contact beds can
reduce the manganese to a level of 1 ppm.

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RANK =       3               -  QL SYSTEMS LIMITED  -         D=   3227  MNT

Publication Date - 740600
Author(S) - Hawley JR
Title - Acid mine drainage abatement.
Citation - Can. Eng J., June 1974, 38.
Accession Number - (CANMET) MNG12299
Accession Date - 750310
Keywords - 1974, acids, drainage, tailings, cat 08, waste
disposal, water, seepage, tailings ponds, sulphur, permeability,
water treatment, conservation, control, neutralization,
oxidation.
Abstract - Notes are included on the lake disposal of tailings,
seepage from permeable and impermeable dams, the recovery and
impoundment of iron sulphide minerals, the reuse of wastewater
at a mining operation, and the treatment of mine wastewaters by
neutralization, oxidation and mechanical aeration.

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RANK =       4               -  QL SYSTEMS LIMITED  -         D=  12312  MNT

Publication Date - 720400
Title - Fourth Symposium on Coal Mine Drainage  Research.
Citation - Fourth Symp Coal Mine Drainage Res, Mellon
Institute, April 26-27, 1972, Pittsburgh, 435 p.
Accession Number - (CANMET) MNG7282
Accession Date - 800408
Keywords - 1972, symposia, coal mines + mining, drainage,
research programs, united states, land reclamation, europe,
water, chemicals, water pollution, flow, fractures, rocks,
ground water, acids, models, sealing, control, oxidation,
neutralization, minerals, extraction, dewatering, filtration,
concentrating, sedimentary rocks, detection, mapping, infrared
analysis, corrosion, bibliographies, cat 08.
Abstract - (1) Reclamation and Mine Tip  Drainage in Europe. (2)
Mine Drainage and Other  Mining Impacts as a Regional
Development. (3)  Chemical Changes in Streamflow Following
Surface  Mining in Eastern Kentucky. (4) Mine Drainage
Demonstration Projects. (5) USBM Progress in  Mine Water

Research. (6) Progress in the  Recognition of Fractured Rock
Zones in Prevention and Abatement of Mine Drainage. (7) Trace
Element Distribution in Reactive and Inert Pyrite. (8)  Acid
Mine Drainage: A Mathematical Model. (9)  Mine Drainage
Pollution Prevention and Abatement  Using Hydrogeological and
Geochemical Systems. (11) Elkins Mine Drainage Pollution Control
Demonstration Project. (10) Evaluation of Mine  Sealing in
Butler County, Penn. (12)  Electrochemical Oxidation of Ferrous
Acid Mine  Waters. (13) Treatment of Ferrous Iron Acid Mine
Waters. (14) Foam Separation of Metals from Acid  Mine Drainage.
(15) Ion Exchange Treatment of  Acid Mine Drainage. (16)
Dewatering Sludge by  Using Rotary Vacuum Precoating Filtration.
(17)  A New Filtration Device for Concentrating  Neutralized
AMD Sludges. (18) Combination  Limestone-Lime Treatment of Acid
Mine Drainage.  (19) Development of a Limestone Treatment
Process  for Acid Mine Drainage. (20) Experience with
Biochemical Iron Oxidation Limestone  Neutralization Process.
(21) Biological Treatment  of Acid Mine Water. (22) Design of
the Oxidation  System for Mine Water Discharges. (23) Airborne
Infrared Detection and Mapping of Coal Mine  Drainage. (24) Use
of Ionic Tracers to Determine  Subsurface Flow of Mine Drainage.
(25) Corrosion  of Navigation Facilities. (26) Chronic Effect
of  Ferric Hydroxide on Certain Species of Aquatic  Animals.
(27) The Recovery of Macrobenthic  Communities from the
Effects of Acid Mine  Drainage. (28) Technical and Economic
Experience  in the Operation of the Slippery Rock Creek Mine
Water Treatment Plant. (29) Mine Drainage  Treatment Experience.
(30) Control of Mine  Drainage from Coal Mine Mineral Wastes.
(31)  Mining and Reclamation Technique to Control Mine
Drainage.

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RANK =       5              - QL SYSTEMS LIMITED  -         D=   9505  MMT

Publication Date - 700000
Author(S) - Caplice D, Shikaze K and Hawley J
Title - Waste Control Problems in the Mining Industry.
Citation - Ont. Ministry of the Environ., Ont. Water Res.
Commiss., 1970-1, 71, (Ref after pap).
Accession Number - (CANMET) MNG18622
Accession Date - 781107
Keywords - cat 08, 1970, 1971, ontario, iron ore mines + mining,
tailings, waste disposal, control, acids, drainage, ph, seepage,
sulphur, water pollution, tailings ponds, bibliographies,
environment, composition.
Abstract - A 1st. paper by Caplice on aspects of waste control
in the mining industry covers waste disposal and ponds, mine
water disposal, tailings overflows and acid mine drainage. 3
papers follow by Hawley on acid mine drainage largely from iron
sulphide mines covering chemical mechanics leading to acid
waters, chemical constituents of acid mine waters, and a step by

step process of controlling acid mine waters.

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RANK =       6              - QL SYSTEMS LIMITED  -         D=  15435  MMT

Publication Date - 800100
Author(S) - Carta M, Del FC, Ghiani M and Rossi G
Title - Effluents and Wastes of Mining and Metallurgical
Installations as Sources of Pollution, and Protective Measures
for Specific Cases.
Citation - Industrie Minerale- Supplement Jan. 1980, 19-30.
Accession Number - (CANMET) MNG21146
Accession Date - 800814
Keywords - cat 08, 1980, europe, french language pubs, mines
+ mining, tailings ponds, water pollution, waste disposal, case
histories, control, filtration, water treatment, critiques and
reviews.
Abstract - In this article in the French a review is made of the
characteristics of waste waters and of solid wastes from mines
and metallurgical processes e.g., acids, toxic heavy metals and
sulphur dioxide, various systems for controlling these 2 kinds
of pollution including settling ponds, drainage filters for
dams, recycling of waste waters, and special collectors for
organic wastes such as carbon adsorption, chemical
precipitation, and biological and chemical oxidation. Waste
disposal of both liquid and solid wastes from Italian sulphide
ore vein deposits and methods of their control are cited
including chrome pollution and its precipitation, drainage of
old waste dumps, and recycling of effluents from flotation
plants.

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RANK =      7              - QL SYSTEMS LIMITED  -        D=  5111  MNT

Publication Date - 740100
Author(S) - Hawley JR
Title - The Abatement of Acid Mine Drainage in Ontario.
Citation - Proceedings of the Sixth Annual Meeting of the
Canadian Mineral Processors, Mines Branch, Dept. of Energy,
Mines and Resources, Jan., 22, 23, 24, 1974.
Accession Number - (CANMET) MMG14194
Accession Date - 760809
Keywords - cat 08, canada, ontario, 1974, waste disposal, dikes
+ dams, pollution, tailings, waste utilization, toxicity,
chemical properties, storage, land reclamation, acids, drainage,
mines + mining, symposia.

Abstract - The progress made in Ontario in the field of acid
drainage waste treatment technology is reviewed. Three reports
published by the Ontario Ministry of Environment are discussed.
The author also discusses the chemistry of acid mine drainage,
the lake disposal of tailings, permeable vs impermeable tailings
dams, recovery and impoundment of iron sulphide minerals,
wastewater reuse at mining operations, mandatory bonds for mine
waste revegetation, problems with the present-day treatment of
acid mine drainage, and the occurrence of unstable sulphur
compounds in mine-mill effluents.

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RANK =      8              - QL SYSTEMS LIMITED  -        D=  23945  MNT

PUBLICATION DATE:  820600
AUTHOR(S):         Koch DH, Stetson JB and Genes BN
TITLE:             Assessment of ground and surface water
                   effects around coal and  mineral storage
                   areas.
CITATION:          U.S. Dept. of Commerce, National Technical
                   Information Service,  PB83-168575, 308pp., 77
                   ref., July 1982.
ACCESSION NUMBER:  CANMET MMG25970
ACCESSION DATE:    830706
ABSTRACT:          Ten coal and mineral stockpile sites
                   (phosphate, lead, copper,  iron and
                   uranium) across the U.S. were visited to
                   determine the  actual impact of coal and
                   mineral stockpiles on water quality.  A
                   series of leaching experiments was conducted
                   in which drainage  from coals and minerals
                   was controlled and monitored to survey  the
                   extent to which storage piles release toxic
                   ions to ground  and surface waters.
                   Pollution abatement techniques were reviewed
                   in 3 generic treatment examples applied to
                   lead-zinc ore, eastern  coal, and uranium ore
                   stockpile leachate.  Water quality impacts
                   are site specific; and there is a high
                   correlation between the  sulphide content of
                   a mineral and its solution potential.  The
                   selection of the best treatment alternative
                   for a specific coal  or mineral storage area
                   must be based on site specific criteria,
                   pilot studies on representative leachate
                   samples and sound  engineering design.
KEYWORDS:          cat 08, 1982, united states, appraisals,
                   water, coal, minerals,  storage, water
                   pollution, field investigations, leaching,
                   drainage, control, chemicals, bibliographies.

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RANK = 9 - QL SYSTEMS LIMITED - D= 0328 MNT

Publication Date - 761100
Title - Proceedings of the 1st. Annual Meeting Canadian Land Reclamation Association.
Citation - Univ. Guelph, Nov. 1976, 10p.
Accession Number - (CANMET) MNG17427
Accession Date - 780116
Keywords - cat 08, 1976, canada, united states, symposia, land reclamation, universities, coal mines + mining, tailings, dumps, compacting, waste (rock), sedimentary rocks, voids, vegetative stabilization, united kingdom, tailings ponds, water, copper mines + mining, zinc mines + mining, sulphur, acids, asbestos mines + mining, alkalies, costs, uranium mines + mining, iron ore mines + mining, waste utilization, open pit mines + mining.
Abstract - Abstracts of papers are included on the following- the effect of compaction of coal shale on the revegetation of spoil heaps, reclamation of coal mine wastes in New Brunswick, a case history of natural underwater revegetation of high sulphide tailings, reclamation of high sulphide tailings at Hudson Bay Mining and Smelting, Flin Flon, a soil and vegetation inventory of coal mine wastes in the mountains of Alberta and B.C., reclamation of asbestos mine wastes, reclamation by vegetation (Canmet), reclamation at Anacondas Jackpile uranium mine, development of an evaluation program for assessing the success of reclamation programs in surface mines, vegetation potential of tailings containing iron sulphides, methods of predicting the success of 13 revegetation species on coal mining disturbed lands in southwestern B.C., and natural succession on strip mined lands in northwestern New Mexico.

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RANK = 10 - QL SYSTEMS LIMITED - D= 1745 MNT

Publication Date - 720000
Author(S) - Hawley JR
Title - The problem of acid mine drainage in the Province of Ontario.
Citation - Ministry of the Environment, Toronto, 1972, 337.
Accession Number - (CANMET) MNG10839
Accession Date - 740619
Keywords - 1972, acids, drainage, ontario, sulphur, cat 08, milling, chemicals, tailings, seepage, flow, oxidation, stability, neutralization, tailings ponds, dikes + dams, conservation, vegetative stabilization, confid.
Abstract - The problem of acid mine drainage is common to the sulphide mines in Ontario. The factors that contribute to it include the chemical composition of the rock mass mined, the geography, the mine-mill circuit, solid and liquid waste disposal practices, the size, location, destination, use and chemical characteristics of the receiving watercourse. 3 waste treatment techniques are mine-mill water reuse, gangue sulphide recovery, and revegetation of abandoned areas. Acid mine drainage problems in Ontario are the result of the decomposition of pyrite, pyrrhotite, and marcasite.

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RANK =      11             - QL SYSTEMS LIMITED -        D=  8418  MNT

Publication Date - 77C700
Author(S) - Moffett D, Zahary G, Campbell MC and Ingles JC
Title - Canmets Environmental and Process Research on Uranium.
Citation - Canmet, M.R.L., Rep. 77-53, July 1977, 29p, (Ref 59).
Accession Number - (CANMET) MMG17517
Accession Date - 780207
Keywords - cat 08, 1977, canada, uranium mines + mining,
environment, critiques and reviews, tailings, tailings ponds,
research programs, experimentation, stabilization, acids,
radioactive isotopes, waste disposal, extraction, concentrating,
beneficiation, separation, sulphur, leaching, milling, water
treatment, bibliographies.
Abstract - A summary is made of Canmet research programs on
tailings disposal and stabilization referring specifically to
rehabilitating pyritic tailings, reducing and identifying acidic
and radioactive wastes, thorium extraction from tailings,
removal of pyrite, preconcentrating radioactive minerals, and
removing chemicals that carry radium in solids tailings.

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RANK =      12             - QL SYSTEMS LIMITED -        D=  20543  MNT

Publication Date - 800100
Author(S) - Fraser DM
Title - Mine-mill waste water treatment at Brunswick Mining.
Citation - 12th Annual Meeting of the Canadian Mineral
Processors, Canada Centre for Mineral and Energy Technology,
Ottawa, Jan 1980, paper no. 7, 114-33.
Accession Number - (CANMET) MMG22567
Accession Date - 810921
Keywords - cat 08, 1980, ontario, new brunswick, symposia, water
treatment, mills, copper mines + mining, zinc mines + mining,
lead mines + mining, acids, drainage, tailings, water pollution,
control, sulphur, beneficiation.
Abstract - A water treatment plant and system was established at
this copper-lead-zinc sulphide deposit in New Brunswick as a 3
phase program to control effluents from the property- phase 1

consisting of surface drainage control and construction of an
acid mine drainage treatment plant to treat mine and mill waters
separately, phase 2 being the establishment of a system to
recycle tailings decant water only, and phase 3 being the
establishment of a system to treat thiosalts in the Canadian
climate. Operation and results and some costs are cited.

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RANK =      13              - QL SYSTEMS LIMITED -        D=  16814  MNT

Publication Date - 690900
Author(S) - Harrison VF
Title - Neutralization and Aeration of Acid Mine  Waters (A
Literature Survey).
Citation - Can Dep Energy Mines Resources, Mines  Branch, Inf
Circ IC 227, Sept. 1969, 41 p.
Accession Number - (CANMET) MNG2922
Accession Date - 801024
Keywords - bibliographies, neutralization, water, water
pollution, mines + mining, acids, alkalies, 1969, critiques and
reviews, canada, cat 08.
Abstract - Research & development work performed  in the United
States during the past twenty years  or more on the
neutralization of waste solutions  containing sulphuric acid and
dissolved iron is  reviewed. The chemistry of mine water is
explained,  and the chemical properties of various types of
limestone & lime are discussed. Also, methods of  applying these
reagents to coal mine drainage and  industrial effluents to
obtain clean water, and of  disposing of the precipitated
sludge, are outlined.  It is suggested that mine water from some
Canadian  mines might be amenable to a limestone treatment
process.

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RANK =      14              - QL SYSTEMS LIMITED -        D=  2774  MNT

Publication Date - 730900
Author(S) - Ross LW
Title - Removal of heavy metals from mine drainage by
precipitation.
Citation - Environ. Prot. Tech. Series, Sept. 1973, Wash., 57p,
(refs p 53).
Accession Number - (CANMET) MNG11857
Accession Date - 741219
Keywords - 1973, extraction, minerals, drainage, water
pollution, control, neutralization, sulphur, chemicals, water

treatment, waste utilization, cat 08, bibliographies.
Abstract - Heavy metals in mine drainage waters of the Rocky
Mountains can be removed by a 2-stage process of neutralization
and by sulphide treatment. The first stage ferric and aluminum
hydroxides and the second sulphide stage precipitates the heavy
metals that are most objectionable as pollutants and that are of
possible interest for economic recovery. The 2-stage process was
demonstrated in the laboratory and in a field experiment.

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RANK = 15 - QL SYSTEMS LIMITED - D= 2655 SDT

Publication Date - 731100
Author(S) - Lovell HL
Title - An appraisal of neutralization processes to treat coal mine drainage.
Citation - Penn. State Univ., Penn., Nov. 1973, 231p, (100 Refs).
Accession Number - (CANMET) MNG11736
Accession Date - 741211
Keywords - 1973, appraisals, neutralization, coal mines + mining, drainage, control, water pollution, chemicals, costs, air, oxidation, dewatering, waste disposal, filtration, bibliographies, cat 08.
Abstract - The treatment of 4 different coal mine drainage waters was studied using neutralization processes. Each of the unit operations from water collection to sludge disposal was considered by drainage reaction with 8 different reagents. Covered are the treatment of coal mine drainage with hydrated lime, calcined lime, to produce high density sludge by recycle, with caustic soda, with soda ash, with dolomitic reagents, and with limestone as well as the biochemical oxidation of iron 2, and sludge control in coal mine drainage treatment.

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RANK = 16 - QL SYSTEMS LIMITED - D= 23566 MDT

PUBLICATION DATE: 820600
AUTHOR(S): Cherry JA and Gillham RW
TITLE: Field and laboratory investigations of acid pore water in pyritic uranium tailings at Elliot Lake, Ontario.
CITATION: Canada Centre for Mineral and Energy Technology, CANMET, contract report 1SU80-00027, 223pp., ref. pp. 180-186, June 1982.

ACCESSION NUMBER: CANMET MNG25590
ACCESSION DATE: 830425
ABSTRACT: A delineation was made of the active zone of pyrite oxidation and an identification of other geochemical processes that play an important role in the evolution of the pore water in the zone above the water table. The pore water, soil-gas, and solid-phase geochemistry and the physical characteristics of tailings were monitored at 3 sites at the Nordic Main tailings pond. A detailed hydrogeochemical explanation was developed for the extent and degree of acidification observed in the Nordic Main and Nordic West tailings. An evaluation specifically was made of the influence of physical hydrology on tailing's chemical evolution, the mechanisms of pyrite oxidation producing a history of acidity, and chemical processes that control the rate of migration of iron, aluminum and low pH conditions. A determination was made of the relative importance of critical factors that control pyrite oxidation rates. Six variables influencing pyrite oxidation rate: oxygen content, microbial mediation, surface area, carbonate buffering, pyrite content, and temperature were lab. investigated under controlled conditions.
KEYWORDS: cat 08, 1982, ontario, field investigations, laboratory experimentation, acids, uranium mines + mining, tailings, oxidation, chemical analysis, sulphur, rate (time), temperature, tailings ponds, research programs, bibliographies.

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RANK = 17 - QL SYSTEMS LIMITED - D= 16567 MNT

Publication Date - 790400

Author(S) - Nebgen JW and Weatherman DF

Title - Evaluation of Chemical Agents for Inhibiting Acid Mine Drainage Formation.

Citation - U.S. Dept. of Commerce, National Technical Information Service, pb 80-176357, April 1979, 125p, (Ref 6).

Accession Number - (CANMET) MNG21365

Accession Date - 801021

Keywords - cat 08, 1979, united states, evaluations, chemicals, drainage, dumps, control, coal mines + mining, underground mines + mining, fly ash, slags, portland cement, water treatment, experimentation, sulphur, bibliographies.

Abstract - Experiments were done on the inhibition of acid mine drainage from underground coal mines in which 3 different pyritic materials were treated with inhibiting agents including fly ash, blast furnace slag, portland cement, and cement kiln dust. These were the best inhibiting agents, and worked by removal of iron 111 ion from solution, an assumption that was confirmed by the action of nails which converted iron 111 to iron 11 and also inhibited the acid-sulphur reactions.

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RANK = 18 - QL SYSTEMS LIMITED - D= 15716 MNT

Publication Date - 800400

Author(S) - Kuit WJ

Title - Mine and Tailings Effluent Treatment at the Kimberley, B.C., Operations of Cominco Ltd.

Citation - 82nd Annual General Meeting of Canadian Institute of Mining and Metallurgy, Toronto, April 1980, paper no. 104, 27p, (Ref 4).

Accession Number - (CANMET) MNG21266

Accession Date - 800924

Keywords - cat 08, 1980, british columbia, ontario, symposia, tailings ponds, acids, drainage, control, zinc mines + mining, lead mines + mining, sulphur, water treatment, neutralization, concentrating, bibliographies.

Abstract - A detailed description is given with data of the treatment and storage facilities of the Sullvan mine and concentrator in B.C. which operates a base metal mine, and experiences a water pollution problem of acid-sulphide mine drainage and heavy metals such as lead, zinc and especially iron. Key features of the new 1979 system are the use of an upgraded tailings pond for the storage of metals contaminated effluents, a treatment plant using lime in a high density sludge process and a sludge storage area. The works can deal with a range of variable operating conditions imposed by the weather, drainage flows and soluble metals. This is described as well as the conversion of ferrous iron to ferric.

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RANK = 19 - QL SYSTEMS LIMITED - D= 4300 MNT

Publication Date - 760200
Author(S) - Larson FP and Ross LW
Title - Two Stage Process Chemically Treats Mine Drainage to Remove Dissolved Metals.
Citation - Engng Min J., Feb. 1976, 94-6, (Refs 2).

Accession Number - (CANMET) MNG13382
Accession Date - 760527
Keywords - 1976, drainage, extraction, water pollution, control, neutralization, chemicals, minerals, bibliographies, water treatment, field experimentation.
Abstract - A field test for the control of acid mine drainage is described that first involves lime neutralization to eliminate iron and aluminum, and secondly, involves removal of copper, zinc, manganese, mercury, cadmium, and arsenic by addition of sulphide to the water.

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RANK = 20 - QL SYSTEMS LIMITED - D= 543 MNT

Publication Date - 690900
Title - Christopher attacks mine drainage problem.
Citation - Coal Age, Sept. 1969, 80-2.
Accession Number - (CANMET) MNG9613
Accession Date - 731005
Keywords - 1969, drainage, acids, water pollution, costs, neutralization, oxidation, settling, waste disposal, chemicals, control, control systems, water treatment, cat 08.
Abstract - An acid mine drainage installation for water treatment is described. The water was before treatment of 5.7 pH, acidity 400 and 600ppm of ferrous iron. The water treatment process consists of lime neutralization, aeration of ferrous iron to ferric iron, and settling ponds to remove yellow boy. After treatment the water is of 7 pH, 1-8ppm iron and an alkalinity of 40-100. The sludge handling and handling line.

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RANK =     21              - QL SYSTEMS LIMITED -        D=  12462  MNT

Publication Date - 710000
Author(S) - Beever C and Attridge BA
Title - Opencast Mining at the Swaziland Iron Ore  Development
Co., Ltd.
Citation - Assoc Mine Mgrs S. Afr, 1971, pp 227-322.
Accession Number - (CANMET) MMG7441
Accession Date - 800414
Keywords - 1971, open pit mines + mining, iron ore  mines
+ mining, africa, geology, slopes, stability, water, dewatering,
design, planning, mining methods, grade  control (ore),
computers, blasting, mining machinery, costs, haulage, drainage,
milling, waste disposal, maintenance (equipment), economics, cat
02, cat 07, cat 08.

Abstract - A brief summary of the Bomvu Ridge iron ore deposit
with particular reference to opencast  mining at the Swaziland
Iron ore Development Co. Ltd, the Ngwenya Mine, is made, and
the following  general aspects are covered: geology; mine staff;
 slope stability; changes in pit design; comparison of  pit
designs; planning; computers and planning; mining  operations;
plant; planned maintenance; future trends  in the iron ore
industry; and budgeting and costing.

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RANK =     22              - QL SYSTEMS LIMITED -        D=   9089  MNT

Publication Date - 780500
Title - Tailing, Canadian Regulations and Practice Marine
Disposal Systems.
Citation - World Mng, May 1978, 58-62, (Ref 4).
Accession Number - (CANMET) MMG10201
Accession Date - 780714
Keywords - cat 08, 1978, canada, far east, symposia, legislation
+ regulations, tailings, waste disposal, water, solids
pipelining, water pollution, water treatment, tailings ponds,
foundations, soils, data, sulpher, chemicals, ph.
Abstract - A summary is made of 3 papers on waste disposal of
tailings in Canada and of marine disposal presented at the 11th.
Commonwealth Mining and Metallurgical Congress held in Hong Kong
in 1978. They include Federal waste water controls for the
mining industry in Canada, Waste disposal and waste water
treatment to minimize environmental impact (sulphide wastes and
disposal on muskeg), and marine disposal of mine and mill
tailings with data on world cases.

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RANK =     23                - CL SYSTEMS LIMITED -          D=   5061  MBT

Publication Date - 750000
Author(S) - Natarov VD, Tverdokhlebov IP and Kudryavtsev GI
Title - Conservation of Underground Waters When Working Anomaly
Ore Deposits.
Citation - Gornyi Zhurnal, No. 6, 1975, 10-12.
Accession Number - (CANMET) MNG14144
Accession Date - 760729
Keywords - translations, russian language pubs, 1975,
dewatering, iron ore mines + mining, soviet union, drainage,
drawdown, ground water, cat 10.
Abstract - This translation from the original Russian discusses
dewatering plans for a new iron ore mine in the Kursk Magnetic

Anomaly region of Russia. Depressing the water table by up to
45C meters might have produced pollution of the potable water in
the region because of mixing with brackish waters found at
depth. Plans are to dewater primarily the brackish zone which is
separated from potable water by impervious rocks and to backfill
underground workings with hardening fill so as to reduce
subsidence.

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RANK =     24                - CL SYSTEMS LIMITED -          D=   2948  MBT

Publication Date - 730000
Title - Processes, procedures and methods to control pollution
from mining activities.
Citation - Environmental Protection Agency, Wash., 1973, 390p,
(215 Refs).
Accession Number - (CANMET) MNG12019
Accession Date - 750124
Keywords - 1973, control, procedures, water pollution, critiques
and reviews, mines + mining, drainage, ground water, seepage,
waste disposal, erosion, sealing, vegetative stabilization, land
reclamation, neutralization, acids, extraction, water treatment,
freezing, oxidation, bibliographies, costs, cat 08.
Abstract - Information is given on techniques of at source water
pollution control applicable to both surface and underground
mining including - pollution control planning for future surface
mining, controlled mining methods, water infiltration control,
handling pollution forming materials, waste water control,
regrading, erosion control, revegetation, controlled mining
procedures, water infiltration control, waste water control,
mine sealing, neutralization processes, neutralization with
limestone, and lime, sludge disposal, evaporation processes,
reverse osmosis, electrodialysis, ion exchange processes,
freezing, and iron oxidation.

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RANK = 25 - QL SYSTEMS LIMITED - D= 24171 MET

PUBLICATION DATE: 820000
AUTHOR(S): Kim AG, Heisey BS, Kleinmann RLP and DuelMN
TITLE: Acid mine drainage: control and abatement research. (Le drainage des mines acides: recherche sur la diminution et le controle des mines acides).
CITATION: U.S. Dept.of the Interior, Bureau of Mines Information Circular, IC 8905, 25pp., 38 ref., 1982.
ACCESSION NUMBER: CANMET MMG26196
ACCESSION DATE: 830916
ABSTRACT: A review is included of the acid mine drainage problem from underground coal mines and coal refuse piles in general as well as of research underway at the USBM to combat it. The research is orientated towards improving water treatment efficiency and developing low maintenance treatment systems. Areas of investigation are: improved iron oxidation efficiency, limestone neutralization, disposal of acid mine drainage sludge, and development of an artificial bog treatment system.
KEYWORDS: cat 08, 1982, united states, research programs, acids, drainage, control, coal mines + mining, dumps, water treatment, neutralization, oxidation, waste disposal, water pollution, bibliographies, underground mines + mining.

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RANK = 26 - QL SYSTEMS LIMITED - D= 20891 MET

Publication Date - 811000
Author(S) - Ben-min F and In-min C
Title - Experimental research work on the use of industrial waste products as antipirogenic agents for the prevention of fires breaking out in result of self-ignition of coal in collieries.
Citation - XIX International Conference of Research Institutes in Safety in Mines, Katowice, Poland, Oct 1981, v. 2, M-6, 631-48, (Ref 4).
Accession Number - (CANMET) MMG22911
Accession Date - 811224
Keywords - cat 06, 1981, china, poland, symposia, safety, experimentation, fires, coal, coal mines + mining, underground mines + mining, spontaneous combustion, control, waste utilization, chemicals, materials, bibliographies.
Abstract - Based on lab. experiments chemical compounds such as calcium, magnesium, zinc and aluminum chlorides act as good inhibitors on brown and hard coal and water glass and slaked lime have similar effects on coal with a larger ferric sulphide content. Field experiments with industrial wastes in both brown and hard coal mines in China confirmed the good inhibiting properties of antipirogenic wastes. They can be used both in heated pillars and in multilayer longwall waste, are simple to use, and can be used in mines having a big fire hazard and a shortage of water and clay for silting. The chemical mechanism of the inhibiting agents is explained in terms of free radical chemistry, and the importance of their moisture retaining properties is cited.

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BANK = 27 - QL SYSTEMS LIMITED - D= 20549 MNT

Publication Date - 800100
Author(S) - Typliski RV and Labarre GJ
Title - Wastewater treatment at Hudson Bay Mining and Smelting Co. ltd, Flin Flon, Manitoba.
Citation - 12th Annual Meeting of the Canadian Mineral Processors, Canada Centre for Mineral and Energy Technology, Ottawa, Jan 1980, paper no. 8, 131-47, (Ref 2).
Accession Number - (CANMET) MNG22573
Accession Date - 810921
Keywords - cat 08, 1980, manitoba, ontario, symposia, beneficiation, water treatment, neutralization, zinc mines + mining, separation, water pollution, control, waste disposal, conservation, waste utilization, bibliographies.
Abstract - The company developed a 2-stage lime neutralization, sludge recirculation and conventional mechanical thickening process that treats 600 cubic m per day of wastewater containing 30-60 mg per 1 of zinc showing metal extraction efficiencies of 99 percent reducing it to 0.2-20 mg per 1 of zinc in the treated effluent. Higher rates of 800 cubic m per day have resulted. The slaked lime slurry is used to precipitate the heavy metal hydroxide at a ph of 9.5-11, and while this stage of the process successfully precipitated out iron and copper it showed little separation efficiency for lead.

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BANK = 28 - QL SYSTEMS LIMITED - D= 13313 MNT

Publication Date - 680700
Author(S) - Rosenbaum JB and Dean KC
Title - Utilization and Stabilization of Solid Mineral Wastes.
Citation - Proc of Eng Foundation Research Conf., Beaver Dam, Wisc., July 22-26, 1968, Preprint C-13, 4p.
Accession Number - (CANMET) MNG6469
Accession Date - 800521
Keywords - 1968, symposia, waste disposal, waste utilization, dust, leaching, extraction, tailings, construction, chemical stabilization, vegetative stabilization, united states, cat 08.
Abstract - This report reviews work in progress at the Salt Lake City Metallurgy Research Centre on selected mineral waste accumulations under respective utilization and stabilization categories. Methods for recovering zinc and lead from foundry flue dust include fuming, acid leaching, and acid or ferrous sulphate baking followed by water leaching. Copper can be precipitated from leach solutions in which auto steel scrap is tumbled. Sulphur, iron, and copper can be recovered from flotation mill tailings by flotation and roasting. Bricks can be made from copper tailings and desulfied tailings from two sources. Sodium silicate, lime, lignin sulfonates, redwood bark extracts, amines, acetate salts of amines, and other chemicals are effective chemical stabilizers. Research on vegetative stabilization at Utah State and the USBM are mentioned especially a method which combines chemical and vegetative stabilization.

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BANK =      29              -  QL SYSTEMS LIMITED  -        D=  12098  MNT

Publication Date - 720000
Author(S) - Ikegami T
Title - Recent Practice of Waste Water Treatment at  Yanahara
Mine.
Citation - Print No.T-III-b-2, Joint Meeting Min Metall Inst Jpn
- Am Inst Min, Metall & Petrol Eng,  Tokyo, 1972, 10 p.
Accession Number - (CANMET) MBG7669
Accession Date - 800319
Keywords - waste disposal, water, drainage, oxidation,
neutralization, acids, sedimentary rocks, temperature, control,
water pollution, minerals, cat 08, japan, symposia, 1972.
Abstract - A report is made on a mine water  drainage treatment
operation at Yanahara mine. Major focuses are placed on ferrous
iron oxidation processes, iron-aluminum replacement, and two
stage  neutralization processes. Covered are: the history  of
the mine water treatment, the characteristics of  the mine
water, treatment practices of the A water,  and treatment
practices of the B water. Flowsheets  and data are included.

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BANK =      30              -  QL SYSTEMS LIMITED  -        D=   4827  MNT

Publication Date - 740400
Title - Fifth Mines Branch Report on Environmental Improvement.
Citation - Canmet, Admin. Rep. 74-1, April 1974, 69p.
Accession Number - (CANMET) MBG13909
Accession Date - 760630
Keywords - 1974, canada, environment, dust, radon gas, measuring
instruments, noise, exhaust gases, coal, cat 08, engines

+ motors, vegetative stabilization, coal, washing, flocculants
+ flocculation, solids pipelining, sulphur, extraction, oil,
combustion, water pollution, research programs, experimentation,
erosion, tailings, waste utilization, energy, conservation,
heating, heat transfer, air pollution.
Abstract - The program for 1973 covers the mine environment
control program, diesel engine emissions, mine waste
revegetation, coal washing and flocculation, manufacture,
handling and transport of coke, desulphurization of oil before
combustion, sources of oil spills, weathering of mill tailings,
adsorption of trace amounts of metal ions by clay, recovery and
conversion of mineral wastes, pyrometallurgical process
modification and waste use, control of solid wastes from
metallurgical plants, control of effluent quality from
metallurgical plants by ion exchange, characteristics of pyrite,
fuel conservation, pollution control, efficient industrial
combustion systems, improving heat transfer efficiency,
dispersion of industrial plumes, energy penalties and
environmental constraints, and fuel efficiency in house oil
heating and energy from garbage and industrial waste.

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RANK =      31              - CL SYSTEMS LIMITED -          D=   4235  MNT

Publication Date - 730300
Author(S) - Wilmoth RC and Hill RD
Title - Mine Drainage Pollution Control Via Reverse Osmosis.
Citation - Mining Engng., March, 1973, pp. 45-47.
Accession Number - (CANMET) MNG13317
Accession Date - 760525
Keywords - 1973, united states, desalination, cat 08, water
treatment, drainage, water pollution, waste disposal.
Abstract - Neutralization and aeration removes acidity, iron and
some other metals but does not remove soluble salts. Reverse
osmosis (RO) removes many dissolved salts. RO is the flow of
water through a semi-permeable membrane to leave dissolved salts
behind while a pressure greater than osmotic pressure is applied
to the solution (mine water from which Fi and Mn is to be
retained by RO). Author discusses water recovery problems, iron
fouling, membrane life, total system approach, and RO
configurations.

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RANK =      32              - CL SYSTEMS LIMITED -          D=   3069  MNT

Publication Date - 740400

Author(S) - Oko UM and Taylor WLW
Title - Treatment of acid mine wastewater at Falconbridges Hardy
Crown pillar project.
Citation - CIM Bull., April 1974, 43-9, (2 Refs).
Accession Number - (CANMET) MNG12140
Accession Date - 750213
Keywords - 1974, acids, dewatering, overburden, cat 06, ground
water, minerals, underground mines + mining, water pollution,
wells, neutralization, water treatment, costs, bibliographies.
Abstract - A discussion is made of the dewatering of the
overburden covering the orebody and the environmental control
problems due to large quantities of dissolved iron and high
acidity of the aquifer. Described are the Hardy orebody, the
overburden, dewatering wells, water quality, treatment of waste
water, water treatment plant, discharge of treated water, cost
of treatment system, operations of the treatment plant.

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BANK =      33              - QL SYSTEMS LIMITED -          D= 23539  MNT

PUBLICATION DATE:   821017
AUTHOR(S):          Poling GW, Revnitsev VJ, Pelletier CA,
                    Doyle EN, Lenton J  and Ellis DV
TITLE:              Round table seminar on submarine and lake
                    disposal of mill  tailings.
CITATION:           XIV International Mineral Processing
                    Congress- Worldwide  Industrial Application
                    of Mineral Processing Technology, Oct. 17-
                    23, 1982, Toronto, Ontario, Canada, p.X-1,
                    65pp., session X, 65  ref., 1982.
ACCESSION NUMBER:   CANMET MMG25563
ACCESSION DATE:     830420
ABSTRACT:           A set of key questions was answered in
                    preprint form by an  international panel of
                    experts.  The subject matter of the
                    questions were as follows: (1) environmental
                    conditions that  favour lake or marine
                    disposal rather than ponds; (2) factors
                    determining lock up of residual heavy metal
                    values in the  tailings solids; (3)
                    stabilization of heavy metal values
                    contained in tailings solids, the chemicals
                    and how they work,  and their cost; (4)
                    turbidity within the lighted or euphoric zone
                     and its prevention; (5) toxicity of milling
                    chemicals; (6)  prevention and control of
                    acid waters from lakes into which  oxidizable
                    sulphide-rich tailings are placed; (7)
                    localized  containment of solids in a
                    catchment basin vs. widespread  disposal over
                    the ocean bottom in marine disposal; (8)

                    experience  with this type of disposal; (9)
                    information sources on the  subject covering
                    environmental impacts, regulations, and legal
                     aspects; (10) effects on human health or on
                    important biological  resources; (11) capital
                    cost and operating cost for this type of
                    disposal vs. tailings ponds; (12) oxidation
                    and neutralization  treatments for acid
                    generating tailings into lakes, capital and
                    operating costs; (13) modelling; (14) impacts
                    on migratory  species and resident species as
                    well as on commercial fisheries;  and (15)
                    lab. tests to determine the potential hazards
                    of these  methods of tailings disposal.
KEYWORDS:           cat 08, 1982, canada, waste disposal, water,
                    solids pipelining,  symposia, tailings,
                    beneficiation, field investigations,
                    environment, toxicity, chemicals, health,
                    tailings ponds, costs,  neutralization,
                    oxidation, models, hazards, mines + mining,
                    bibliographies.

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RANK = 34 - CL SYSTEMS LIMITED - D= 22675 MNT

Publication Date - 810300
Author(S) - Jones AK, Johnson MS and Bell RM
Title - The control of metal dispersal in reclaimed land.
Citation - Min Mag, March 1981, 249-57, 5p, (Ref 15).
Accession Number - (CANMET) MNG24698
Accession Date - 821105
Keywords - cat 08, 1981, united kingdom, chemicals, land reclamation, control, minerals, pollution, tailings ponds, vegetative stabilization, mines + mining, bibliographies.
Abstract - The problems associated with the contamination of air, soil and water by heavy metals and consequent toxicity to animals and plants from metalliferous mining, smelting and refining are discussed with special reference to the U.K. Aspects covered include dispersal of toxic metals by water and wind erosion of wastes, prevention of dispersal by physical, chemical and especially vegetative stabilization, surface treatments with non-toxic amendments such as topsoil, subsoil, domestic refuse and sewage sludge, and acid generation by highly pyritic material. The strategies for the successful revegetation of metal contaminated land exist, but further research is needed on isolation of waste materials, weathering of tailings and pathways of metals into food chains.

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RANK = 35 - CL SYSTEMS LIMITED - D= 20588 MNT

Publication Date - 790000
Author(S) - Gorber DM, Ibbotson BG and Knapp RA
Title - Environmental considerations related to the mining and milling of uranium.
Citation - Management of Radioactive Wastes in Canada, Symposium, Toronto, 1981, Canadian Nuclear Association, Toronto, 19-34.
Accession Number - (CANMET) MNG22533
Accession Date - 810930
Keywords - cat 08, 1979, canada, symposia, management, waste disposal, radioactive isotopes, environment, uranium mines + mining, milling, pollution, control, chemicals, tailings.
Abstract - The aspects described are mainly based on experience with the Elliot Lake mines specifically tailings, the acid leach process and a pyrite bearing ore, and considerations are discussed relating to air and water pollution chemically and radioactively with aspects of monitoring and control mentioned for the long and short term effects.

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RANK =      36              - QL SYSTEMS LIMITED -          D=  20555  MNT

Publication Date - 800100
Title - Proceedings of the 12th Annual Meeting of the Canadian
Mineral Processors.
Citation - Canada Centre for Mineral and Energy Technology,
Ottawa, Jan 1980, 425p.
Accession Number - (CANMET) MNG22580
Accession Date - 810929
Keywords - cat 08, cat 05, 1980, ontario, symposia,
beneficiation, water treatment, waste disposal, land
reclamation, solids pipelining.
Abstract - Eight papers of interest from this conference are
water policy at Inco Metals Co. Mills Ontario Division, removal
of heavy metals from tailings recycle water at Mattabi Mines
Ltd., wastewater treatment at Hudson Bay Mining and Smelting Co.
Ltd., mine and tailings effluent treatment at the Kimberley,
B.C. operations of Cominco Ltd., acidic effluents, their
production and characteristics, aspects of tailings reclamation
in Ontario and Quebec, and slurry pump and pipeline performance
testing at Georgia Iron Works hydraulic laboratory.

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RANK =      37              - QL SYSTEMS LIMITED -          D=  11832  MNT

Publication Date - 780000
Author(S) - Edgeworth I, Cornwall GM and Scott JS
Title - Federal Waste-Water Controls for the Mining Industry in
Canada.
Citation - 11th. Commonwealth Mining and Metallurgical Congress.
Hong Kong, 1978, ed. M.J. Jones, 818p, 413-20.
Accession Number - (CANMET) MNG20419
Accession Date - 800303
Keywords - cat 08, 1978, far east, canada, symposia, legislation
+ regulations, zinc mines + mining, radioactive isotopes, lead
mines + mining, zinc mines + mining, copper mines + mining,
uranium mines + mining, iron ore mines + mining, mine
development, water pollution, toxicity, ecology, damages, ph,
control, sampling, water analysis, monitoring.
Abstract - Regulations and guidelines issued in March 1977 by
the Environmental Protection Service of the Canada Dept. of
Fisheries and the Environment for the control of liquid
effluents from base metal, uranium and iron ore mines and mills
are described. They are law for new, expanded or reopened
properties and guidelines for ongoing ones. Limits are
prescribed for arsenic, copper, lead, nickel, total suspended
solids, radium 226, zinc, acute fish toxicity, and pH. They
describe sampling, analytical and reporting requirements, and
the acute lethality test for fish companies to follow. The
efforts of the Wastewater Technology Centre and its program for
the development and demonstration of pollution control are
described.

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RANK =      38              -  QL SYSTEMS LIMITED  -          D=  20843  MNT

Publication Date - 800800
Author(S) - Murray DR
Title - Water movement and contamination in and from sulphide
uranium tailings related to surface treatment and abandonment.
Citation - Canada Centre for Mineral and Energy Technology,
Canmet, Mining Research Lab., Report MRP-MRL 80-91, Aug 1980,
8p, (Ref 5).
Accession Number - (CANMET) MNG22862
Accession Date - 811203
Keywords - cat 08, 1980, canada, uranium mines + mining,
tailings, water pollution, flow, sulphur, vegetative
stabilization, gravels, materials, tailings ponds, ground water,
chemical analysis, water analysis, bibliographies.
Abstract - A field lysimeter study was done to examine the
influence of surface treatment (vegetation, gravel and sawdust)
on effluent quality and quantity, and the effluent quality from
tailings with most of the pyrite removed was investigated. The
reaction processes are being studied and include both
unsaturated and saturated zones. Differential movement of the
contaminants from the tailings occurs, and a study will be made

of the flow net pattern and of the correlation between profile
solid content and water content for various contaminants.
Problems with preliminary results are described.

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RANK =      39              -  QL SYSTEMS LIMITED  -          D=  20795  MNT

Publication Date - 801200
Author(S) - Cherry JA, Blackport RJ, Dubrovsky N,  Gillham RW
and Lim TP
Title - Subsurface hydrology and geochemical evolution of
inactive pyritic tailings in the Elliot Lake uranium district,
Canada.
Citation - Canada Centre for Mineral and Energy Technology,
Canmet, Mining Research Lab., Report MRP-MRL 80-121, Dec 1980,
34p, (Ref 9).
Accession Number - (CANMET) MNG22814
Accession Date - 811124
Keywords - cat 08, 1980, ontario, ground water, tailings,
tailings ponds, uranium mines + mining, oxidation, acids, water
analysis, chemical analysis, flow, seepage, water pollution,
vegetative stabilization, field investigations, bibliographies.
Abstract - The oxidation of pyrite is causing pore water in the
tailings at 3 sites to become acidic, and acidification has
continued to occur in areas where the tailings are grass
covered. Moderately acidic water with ph in the range 3-5 is
common in the tailings, and more strongly acidic water of ph 1-3
was detected at only a few locations. Most of the pore water in
the tailings has ph levels above 5. The rate at which acidic
water replaces the original neutral water in the tailings
depends on texture and pyrite content of tailings above the
water table, hydrologic conditions beneath the tailings,
hydraulic conductivity and degree of layering of the tailings,
supply of water as rain and slope runoff to the surface of the
tailings, and the type and density of vegetation established on
the tailings surface.

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RANK =      40              - QL SYSTEMS LIMITED  -          D=   1753  ANY

      Publication Date - 731100
      Title - Destratification - a promising lake saver.
      Citation - Water and Pollution Control, Nov. 1973, 20.
      Accession Number - (CANNET) NNG10848
      Accession Date - 740619
      Keywords - 1973, water pollution, control, cat 08, compressed

      air, mixing, water supply, water, water treatment.
      Abstract - A method of controlling stagnant lake conditions is
      to install a source of compressed air in the water body and mix
      the water layers with it. In one case the mixing of the lake
      resulted in improved water quality re. hydrogen sulphide,
      dissolved oxygen, carbon dioxide, ammonia, nitrogen, total
      phosphorus and iron. Algal crops increased, secchi disk readings
      decreased, and zoo-plankton populations increased. Other cases
      of the beneficial effects of the process are cited.

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            949 LINES,       40 DOCUMENTS           END OF PRINT REQUEST
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P

APPENDIX P

MINING TECHNOLOGY (MNT) DATABASE

SEARCH #2 OF 2

SEARCH STRATEGY:

[DRAINAGE OR WATER(S) OR WASTE(S) OR WASTEWATER(S)]

AND

[PYRIT? OR SULPHIDE OR SULFIDE OR IRON]

NOT

[SEARCH #1]

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RANK =       1              - QL SYSTEMS LIMITED -         D=  13027  MNT

Publication Date - 720000
Author(S) - Hawley JR
Title - The Problem of Acid Mine Drainage in the  Province of
Ontario.
Citation - Ontario Water Resources Commission, Div. of
Industrial Wastes, 1972, 338 p. (Ref).
Accession Number - (CANMET) MMG6705
Accession Date - 800507
Keywords - 1972, acids, drainage, ontario, minerals, chemicals,
tailings, chemical analysis, water  pollution, oxidation,
neutralization, control, seepage, vegetative stabilization,
dikes + dams, sealing, bibliographies, sulphur, cat 08.
Abstract - The problem of acid mine drainage is  common to the
sulphide mines in Ontario,  and the factors that contribute to
it are various.  The drainage problems are the result of
decomposition of the iron minerals pyrite, pyrrhotite, and
marcasite. The problem continues long  after the mine is closed,
and conventional  mine-mill waste treatments cannot by
themselves  achieve a product that can be discharged into a
natural watercourse. Three waste treatments of acid  mine
drainage that should be considered are: mine-mill wastewater
reuse, gangue sulphide recovery, and  revegetation of abandoned
or unused areas.

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RANK =       2              - QL SYSTEMS LIMITED -         D=  18394  MNT

Publication Date - 750000
Author(S) - Smith JP
Title - Eagle Mine Wastewater Control.
Citation - Water Quality Management for the Metals and Minerals
Industry, short course in conjunction with 104th Annual Meeting
of AIME, New York, 1975, 142p, American Institute of Mining,
Metallurgical and Petroleum Engineers, paper 9p.
Accession Number - (CANMET) MMG21574
Accession Date - 801229
Keywords - cat 08, 1975, united states, zinc mines + mining,
quality control, management, minerals, water, waste disposal,
water pollution, acids, drainage, neutralization, water
treatment.
Abstract - Water treatment for a zinc mine in the Rocky
Mountains in Colorado is described being mainly acid drainage
and heavy metal contamination. The discharge waters from the
ponds contain high levels of pyrite in conjunction with
manganese leading in turn to high levels of zinc, iron and
manganese. A description is given of the use of neutralization
with lime to give a pH above 9 and reducing the zinc below 1
ppm, iron below 2 ppm, and manganese below 2.5 ppm. A lab.
demonstration showed that crushed pyrolusite contact beds can
reduce the manganese to a level of 1 ppm.
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RANK = 3 - QL SYSTEMS LIMITED - D= 3227 MBT

Publication Date - 740600
Author(S) - Hawley JB
Title - Acid mine drainage abatement.
Citation - Can. Mng J., June 1974, 38.
Accession Number - (CANMET) MNG12299
Accession Date - 750310
Keywords - 1974, acids, drainage, tailings, cat 08, waste disposal, water, seepage, tailings ponds, sulphur, permeability, water treatment, conservation, control, neutralization, oxidation.
Abstract - Notes are included on the lake disposal of tailings, seepage from permeable and impermeable dams, the rucovery and impoundment of iron sulphide minerals, the reuse of wastewater at a mining operation, and the treatment of mine wastewaters by neutralization, oxidation and mechanical aeration.

RANK = 4 - QL SYSTEMS LIMITED - D= 12312 MBT

Publication Date - 720400
Title - Fourth Symposium on Coal Mine Drainage Research.
Citation - Fourth Symp Coal Mine Drainage Res, Mellon Institute, April 26-27, 1972, Pittsburgh, 435 p.
Accession Number - (CANMET) MNG7282
Accession Date - 800408
Keywords - 1972, symposia, coal mines + mining, drainage, research programs, united states, land reclamation, europe, water, chemicals, water pollution, flow, fractures, rocks, ground water, acids, models, sealing, control, oxidation, neutralization, minerals, extraction, dewatering, filtration, concentrating, sedimentary rocks, detection, mapping, infrared analysis, corrosion, bibliographies, cat 08.
Abstract - (1) Reclamation and Mine Tip Drainage in Europe. (2) Mine Drainage and Other Mining Impacts as a Regional Development. (3) Chemical Changes in Streamflow Following Surface Mining in Eastern Kentucky. (4) Mine Drainage Demonstration Projects. (5) USBM Progress in Mine Water Research. (6) Progress in the Recognition of Fractured Rock Zones in Prevention and Abatement of Mine Drainage. (7) Trace Element Distribution in Reactive and Inert Pyrite. (8) Acid Mine Drainage: A Mathematical Model. (9) Mine Drainage Pollution Prevention and Abatement Using Hydrogeological and Geochemical Systems. (11) Elkins Mine Drainage Pollution Control Demonstration Project. (10) Evaluation of Mine Sealing in Butler County, Penn. (12) Electrochemical Oxidation of Ferrous Acid Mine Waters. (13) Treatment of Ferrous Iron Acid Mine Waters. (14) Foam Separation of Metals from Acid Mine Drainage. (15) Ion Exchange Treatment of Acid Mine Drainage. (16) Dewatering Sludge by Using Rotary Vacuum Precoating Filtration. (17) A New Filtration Device for Concentrating Neutralized AMD Sludges. (18) Combination Limestone-Lime Treatment of Acid Mine Drainage. (19) Development of a Limestone Treatment Process for Acid Mine Drainage. (20) Experience with Biochemical Iron Oxidation Limestone Neutralization Process. (21) Biological Treatment of Acid Mine Water. (22) Design of the Oxidation System for Mine Water Discharges. (23) Airborne Infrared Detection and Mapping of Coal Mine Drainage. (24) Use of Ionic Tracers to Determine Subsurface Flow of Mine Drainage. (25) Corrosion of Navigation Facilities. (26) Chronic Effect of Ferric Hydroxide on Certain Species of Aquatic Animals. (27) The Recovery of Macrobenthic Communities from the Effects of Acid Mine Drainage. (28) Technical and Economic Experience in the Operation of the Slippery Rock Creek Mine Water Treatment Plant. (29) Mine Drainage Treatment Experience. (30) Control of Mine Drainage from Coal Mine Mineral Wastes. (31) Mining and Reclamation Technique to Control Mine Drainage.

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RANK =        5      .      - QL SYSTEMS LIMITED  -        D=  9505  MNT

Publication Date - 700000
Author(S) - Caplice D, Shikaze K and Hawley J
Title - Waste Control Problems in the Mining Industry.
Citation - Ont. Ministry of the Environ., Ont. Water Res.
Commiss., 1970-1, 71, (Ref after pap).
Accession Number - (CANMET) MMG18622
Accession Date - 781107
Keywords - cat 08, 1970, 1971, ontario, iron ore mines + mining,
tailings, waste disposal, control, acids, drainage, ph, seepage,
sulphur, water pollution, tailings ponds, bibliographies,
environment, composition.
Abstract - A 1st. paper by Caplice on aspects of waste control
in the mining industry covers waste disposal and ponds, mine
water disposal, tailings overflows and acid mine drainage. 3
papers follow by Hawley on acid mine drainage largely from iron
sulphide mines covering chemical mechanics leading to acid
waters, chemical constituents of acid mine waters, and a step by

step process of controlling acid mine waters.

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RANK =        6             - QL SYSTEMS LIMITED  -        D=  15435  MNT

Publication Date - 800100
Author(S) - Carta M, Del FC, Ghiani M and Rossi G
Title - Effluents and Wastes of Mining and Metallurgical
Installations as Sources of Pollution, and Protective Measures
for Specific Cases.
Citation - Industrie Minerale- Supplement Jan. 1980, 19-30.
Accession Number - (CANMET) MMG21146
Accession Date - 800814
Keywords - cat 08, 1980, europe, french language pubs, mines
+ mining, tailings ponds, water pollution, waste disposal, case
histories, control, filtration, water treatment, critiques and
reviews.
Abstract - In this article in the French a review is made of the
characteristics of waste waters and of solid wastes from mines
and metallurgical processes e.g., acids, toxic heavy metals and
sulphur dioxide, various systems for controlling these 2 kinds
of pollution including settling ponds, drainage filters for
dams, recycling of waste waters, and special collectors for
organic wastes such as carbon adsorption, chemical
precipitation, and biological and chemical oxidation. Waste
disposal of both liquid and solid wastes from Italian sulphide
ore vein deposits and methods of their control are cited
including chrome pollution and its precipitation, drainage of
old waste dumps, and recycling of effluents from flotation
plants.
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RANK = 7 - QL SYSTEMS LIMITED - D= 5111 MNT

Publication Date - 740100
Author(S) - Hawley JR
Title - The Abatement of Acid Mine Drainage in Ontario.
Citation - Proceedings of the Sixth Annual Meeting of the Canadian Mineral Processors, Mines Branch, Dept. of Energy, Mines and Resources, Jan., 22, 23, 24, 1974.
Accession Number - (CANMET) MNG14194
Accession Date - 760809
Keywords - cat 08, canada, ontario, 1974, waste disposal, dikes + dams, pollution, tailings, waste utilization, toxicity, chemical properties, storage, land reclamation, acids, drainage, mines + mining, symposia.

Abstract - The progress made in Ontario in the field of acid drainage waste treatment technology is reviewed. Three reports published by the Ontario Ministry of Environment are discussed. The author also discusses the chemistry of acid mine drainage, the lake disposal of tailings, permeable vs impermeable tailings dams, recovery and impoundment of iron sulphide minerals, wastewater reuse at mining operations, mandatory bonds for mine waste revegetation, problems with the present-day treatment of acid mine drainage, and the occurrence of unstable sulphur compounds in mine-mill effluents.

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RANK = 8 - QL SYSTEMS LIMITED - D= 23945 MNT

PUBLICATION DATE: 820600
AUTHOR(S): Koch DH, Stetson JR and Genes BR
TITLE: Assessment of ground and surface water effects around coal and mineral storage areas.
CITATION: U.S. Dept. of Commerce, National Technical Information Service, PB83-168575, 308pp., 77 ref., July 1982.
ACCESSION NUMBER: CANMET MNG25970
ACCESSION DATE: 830706
ABSTRACT: Ten coal and mineral stockpile sites (phosphate, lead, copper, iron and uranium) across the U.S. were visited to determine the actual impact of coal and mineral stockpiles on water quality. A series of leaching experiments was conducted in which drainage from coals and minerals was controlled and monitored to survey the extent to which storage piles release toxic ions to ground and surface waters. Pollution abatement techniques were reviewed in 3 generic treatment examples applied to lead-zinc ore, eastern coal, and uranium ore stockpile leachate. Water quality impacts are site specific; and there is a high correlation between the sulphide content of a mineral and its solution potential. The selection of the best treatment alternative for a specific coal or mineral storage area must be based on site specific criteria, pilot studies on representative leachate samples and sound engineering design.
KEYWORDS: cat 08, 1982, united states, appraisals, water, coal, minerals, storage, water pollution, field investigations, leaching, drainage, control, chemicals, bibliographies.

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BANK = 9 - QL SYSTEMS LIMITED - D= 0328 HNT

Publication Date - 761100

Title - Proceedings of the 1st. Annual Meeting Canadian Land Reclamation Association.

Citation - Univ. Guelph, Nov. 1976, 10p.

Accession Number - (CANMET) MNG17427

Accession Date - 780116

Keywords - cat 08, 1976, canada, united states, symposia, land reclamation, universities, coal mines + mining, tailings, dumps, compacting, waste (rock), sedimentary rocks, voids, vegetative stabilization, united kingdom, tailings ponds, water, copper mines + mining, zinc mines + mining, sulphur, acids, asbestos mines + mining, alkalies, costs, uranium mines + mining, iron ore mines + mining, waste utilization, open pit mines + mining.

Abstract - Abstracts of papers are included on the following- the effect of compaction of coal shale on the revegetation of spoil heaps, reclamation of coal mine wastes in New Brunswick, a case history of natural underwater revegetation of high sulphide tailings, reclamation of high sulphide tailings at Hudson Bay Mining and Smelting, Flin Flon, a soil and vegetation inventory of coal mine wastes in the mountains of Alberta and B.C., reclamation of asbestos mine wastes, reclamation by vegetation (Canmet), reclamation at Anacondas Jackpile uranium mine, development of an evaluation program for assessing the success of reclamation programs in surface mines, vegetation potential of tailings containing iron sulphides, methods of predicting the success of 13 revegetation species on coal mining disturbed lands in southwestern B.C., and natural succession on strip mined lands in northwestern New Mexico.

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BANK = 10 - QL SYSTEMS LIMITED - D= 1745 HNT

Publication Date - 720000

Author(S) - Hawley JR

Title - The problem of acid mine drainage in the Province of Ontario.

Citation - Ministry of the Environment, Toronto, 1972, 337.

Accession Number - (CANMET) MNG10839

Accession Date - 740619

Keywords - 1972, acids, drainage, ontario, sulphur, cat 08, milling, chemicals, tailings, seepage, flow, oxidation, stability, neutralization, tailings ponds, dikes + dams, conservation, vegetative stabilization, confid.

Abstract - The problem of acid mine drainage is common to the sulphide mines in Ontario. The factors that contribute to it include the chemical composition of the rock mass mined, the geography, the mine-mill circuit, solid and liquid waste disposal practices, the size, location, destination, use and chemical characteristics of the receiving watercourse. 3 waste treatment techniques are mine-mill water reuse, gangue sulphide recovery, and revegetation of abandoned areas. Acid mine drainage problems in Ontario are the result of the decomposition of pyrite, pyrrhotite, and marcasite.

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RANK =      11              -  QL SYSTEMS LIMITED  -          D=   8418  MNT

Publication Date - 770700
Author(S) - Moffett D, Zahary G, Campbell MC and Ingles JC
Title - Canmets Environmental and Process Research on Uranium.
Citation - Canmet, M.E.L., Rep. 77-53, July 1977, 29p, (Ref 59).
Accession Number - (CANMET) MMG17517
Accession Date - 780207
Keywords - cat 08, 1977, canada, uranium mines + mining,
environment, critiques and reviews, tailings, tailings ponds,
research programs, experimentation, stabilization, acids,
radioactive isotopes, waste disposal, extraction, concentrating,
beneficiation, separation, sulphur, leaching, milling, water
treatment, bibliographies.
Abstract - A summary is made of Canmet research programs on
tailings disposal and stabilization referring specifically to
rehabilitating pyritic tailings, reducing and identifying acidic
and radioactive wastes, thorium extraction from tailings,
removal of pyrite, preconcentrating radioactive minerals, and
removing chemicals that carry radium in solids tailings.

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RANK =      12              -  QL SYSTEMS LIMITED  -          D=  20543  MNT

Publication Date - 800100
Author(S) - Fraser DM
Title - Mine-mill waste water treatment at Brunswick Mining.
Citation - 12th Annual Meeting of the Canadian Mineral
Processors, Canada Centre for Mineral and Energy Technology,
Ottawa, Jan 1980, paper no. 7, 114-30.
Accession Number - (CANMET) MMG22567
Accession Date - 810921
Keywords - cat 08, 1980, ontario, new brunswick, symposia, water
treatment, mills, copper mines + mining, zinc mines + mining,
lead mines + mining, acids, drainage, tailings, water pollution,
control, sulphur, beneficiation.
Abstract - A water treatment plant and system was established at
this copper-lead-zinc sulphide deposit in New Brunswick as a 3
phase program to control effluents from the property- phase 1

consisting of surface drainage control and construction of an
acid mine drainage treatment plant to treat mine and mill waters
separately, phase 2 being the establishment of a system to
recycle tailings decant water only, and phase 3 being the
establishment of a system to treat thiosalts in the Canadian
climate. Operation and results and some costs are cited.
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RANK =      13              -  QL SYSTEMS LIMITED  -        D=  16814  MNT

Publication Date - 690900
Author(S) - Harrison VF
Title - Neutralization and Aeration of Acid Mine  Waters (A
Literature Survey).
Citation - Can Dep Energy Mines Resources, Mines  Branch, Inf
Circ IC 227, Sept. 1969, 41 p.
Accession Number - (CANMET) MNG2922
Accession Date - 801024
Keywords - bibliographies, neutralization, water, water
pollution, mines + mining, acids, alkalies, 1969, critiques and
reviews, canada, cat 08.
Abstract - Research & development work performed  in the United
States during the past twenty years  or more on the
neutralization of waste solutions  containing sulphuric acid and
dissolved iron is  reviewed. The chemistry of mine water is
explained,  and the chemical properties of various types of
limestone & lime are discussed. Also, methods of  applying these
reagents to coal mine drainage and  industrial effluents to
obtain clean water, and of  disposing of the precipitated
sludge, are outlined.  It is suggested that mine water from some
Canadian  mines might be amenable to a limestone treatment
process.

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RANK =      14              -  QL SYSTEMS LIMITED  -        D=   2774  MNT

Publication Date - 730900
Author(S) - Ross LW
Title - Removal of heavy metals from mine drainage by
precipitation.
Citation - Environ. Prot. Tech. Series, Sept. 1973, Wash., 57p,
(refs p 53).
Accession Number - (CANMET) MNG11857
Accession Date - 741219
Keywords - 1973, extraction, minerals, drainage, water
pollution, control, neutralization, sulphur, chemicals, water

treatment, waste utilization, cat 08, bibliographies.
Abstract - Heavy metals in mine drainage waters of the Rocky
Mountains can be removed by a 2-stage process of neutralization
and by sulphide treatment. The first stage ferric and aluminum
hydroxides and the second sulphide stage precipitates the heavy
metals that are most objectionable as pollutants and that are of
possible interest for economic recovery. The 2-stage process was
demonstrated in the laboratory and in a field experiment.
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RANK =     15              - QL SYSTEMS LIMITED -         D=   2655  MNT

Publication Date - 731100
Author(S) - Lovell HL
Title - An appraisal of neutralization processes to treat coal
mine drainage.
Citation - Penn. State Univ., Penn., Nov. 1973, 231p, (100
Refs).
Accession Number - (CANMET) MNG11736
Accession Date - 741211
Keywords - 1973, appraisals, neutralization, coal mines
+ mining, drainage, control, water pollution, chemicals, costs,
air, oxidation, dewatering, waste disposal, filtration,
bibliographies, cat 08.
Abstract - The treatment of 4 different coal mine drainage
waters was studied using neutralization processes. Each of the
unit operations from water collection to sludge disposal was
considered by drainage reaction with 8 different reagents.
Covered are the treatment of coal mine drainage with hydrated
lime, calcined lime, to produce high density sludge by recycle,
with caustic soda, with soda ash, with dolomitic reagents, and
with limestone as well as the biochemical oxidation of iron 2,
and sludge control in coal mine drainage treatment.


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RANK =     16              - QL SYSTEMS LIMITED -         D=  23566  MNT

PUBLICATION DATE:   820600
AUTHOR(S):          Cherry JA and Gillham RW
TITLE:              Field and laboratory investigations of acid
                    pore water in  pyritic uranium tailings at
                    Elliot Lake, Ontario.
CITATION:           Canada Centre for Mineral and Energy
                    Technology, CANMET,  contract report
                    15080-00027, 223pp., ref. pp.180-186, June
                    1982.

ACCESSION NUMBER:   CANMET MNG25590
ACCESSION DATE:     830425
ABSTRACT:           A delineation was made of the active zone of
                    pyrite oxidation  and an identification of
                    other geochemical processes that play an
                    important role in the evolution of the pore
                    water in the zone  above the water table.
                    The pore water, soil-gas, and solid-phase
                    geochemistry and the physical characteristics
                    of tailings were  monitored at 3 sites at the
                    Nordic Main tailings pond.  A  detailed
                    hydrogeochemical explanation was developed
                    for the  extent and degree of acidification
                    observed in the Nordic Main  and Nordic West
                    tailings.  An evaluation specifically was
                    made of  the influence of physical hydrology
                    on tailing's chemical  evolution, the
                    mechanisms of pyrite oxidation producing a
                    history  of acidity, and chemical processes
                    that control the rate of  migration of iron,
                    aluminum and low pH conditions.  A
                    determination was made of the relative
                    importance of critical  factors that control
                    pyrite oxidation rates.  Six variables
                    influencing pyrite oxidation rate: oxygen
                    content, microbial  mediation, surface area,
                    carbonate buffering, pyrite content, and
                    temperature were lab. investigated under
                    controlled conditions.
KEYWORDS:           cat 08, 1982, ontario, field investigations,
                    laboratory  experimentation, acids, uranium
                    mines + mining, tailings,  oxidation,
                    chemical analysis, sulphur, rate (time),
                    temperature,  tailings ponds, research
                    programs, bibliographies.
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RANK =      17              -  QL SYSTEMS LIMITED  -          D=  16567  MNT

Publication Date - 790400
Author(S) - Nebgen JW and Weatherman DF
Title - Evaluation of Chemical Agents for Inhibiting Acid Mine
Drainage Formation.
Citation - U.S. Dept. of Commerce, National Technical
Information Service, pb 80-176357, April 1979, 125p, (Ref 6).
Accession Number - (CANMET) MNG21365
Accession Date - 801021
Keywords - cat 08, 1979, united states, evaluations, chemicals,
drainage, dumps, control, coal mines + mining, underground mines
+ mining, fly ash, slags, portland cement, water treatment,
experimentation, sulphur, bibliographies.
Abstract - Experiments were done on the inhibition of acid mine
drainage from underground coal mines in which 3 different
pyritic materials were treated with inhibiting agents including
fly ash, blast furnace slag, portland cement, and cement kiln
dust. These were the best inhibiting agents, and worked by
removal of iron 111 ion from solution, an assumption that was
confirmed by the action of nails which converted iron 111 to
iron 11 and also inhibited the acid-sulphur reactions.

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RANK =      18              -  QL SYSTEMS LIMITED  -          D=  15716  MNT

Publication Date - 800400
Author(S) - Kuit WJ
Title - Mine and Tailings Effluent Treatment at the Kimberley,
B.C., Operations of Cominco Ltd.
Citation - 82nd Annual General Meeting of Canadian Institute of
Mining and Metallurgy, Toronto, April 1980, paper no. 104, 27p,
(Ref 4).
Accession Number - (CANMET) MNG21266
Accession Date - 800924
Keywords - cat 08, 1980, british columbia, ontario, symposia,
tailings ponds, acids, drainage, control, zinc mines + mining,
lead mines + mining, sulphur, water treatment, neutralization,
concentrating, bibliographies.
Abstract - A detailed description is given with data of the
treatment and storage facilities of the Sullvan mine and
concentrator in B.C. which operates a base metal mine, and
experiences a water pollution problem of acid-sulphide mine
drainage and heavy metals such as lead, zinc and especially
iron. Key features of the new 1979 system are the use of an
upgraded tailings pond for the storage of metals contaminated
effluents, a treatment plant using lime in a high density sludge
process and a sludge storage area. The works can deal with a
range of variable operating conditions imposed by the weather,
drainage flows and soluble metals. This is described as well as
the conversion of ferrous iron to ferric.
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RANK =     19              - QL SYSTEMS LIMITED  -        D=   4300  MST

Publication Date - 760200
Author(S) - Larson HP and Ross LW
Title - Two Stage Process Chemically Treats Mine Drainage to
Remove Dissolved Metals.
Citation - Engng Min J., Feb. 1976, 94-6, (Refs 2).

Accession Number - (CANMET) MMG13382
Accession Date - 760527
Keywords - 1976, drainage, extraction, water pollution, control,
neutralization, chemicals, minerals, bibliographies, water
treatment, field experimentation.
Abstract - A field test for the control of acid mine drainage is
described that first involves lime neutralization to eliminate
iron and aluminum, and secondly, involves removal of copper,
zinc, manganese, mercury, cadmium, and arsenic by addition of
sulphide to the water.

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RANK =     20              - QL SYSTEMS LIMITED  -        D=    543  MST

Publication Date - 690900
Title - Christopher attacks mine drainage problem.
Citation - Coal Age, Sept. 1969, 80-2.
Accession Number - (CANMET) MMG9613
Accession Date - 731005
Keywords - 1969, drainage, acids, water pollution, costs,
neutralization, oxidation, settling, waste disposal, chemicals,
control, control systems, water treatment, cat 08.
Abstract - An acid mine drainage installation for water
treatment is described. The water was before treatment of 5.7
pH, acidity 400 and 600ppm of ferrous iron. The water treatment
process consists of lime neutralization, aeration of ferrous
iron to ferric iron, and settling ponds to remove yellow boy.
After treatment the water is of 7 pH, 1-8ppm iron and an
alkalinity of 40-100. The sludge handling and handling line.
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RANK =     21              - QL SYSTEMS LIMITED -         D=  12462  MNT

Publication Date - 710000
Author(S) - Heever C and Attridge DA
Title - Opencast Mining at the Swaziland Iron Ore  Development
Co., Ltd.
Citation - Assoc Mine Mgrs S. Afr, 1971, pp 227-322.
Accession Number - (CANMET) MNG7441
Accession Date - 800414
Keywords - 1971, open pit mines + mining, iron ore  mines
+ mining, africa, geology, slopes, stability, water, dewatering,
design, planning, mining methods, grade  control (ore),
computers, blasting, mining machinery, costs, haulage, drainage,
milling, waste disposal, maintenance (equipment), economics, cat
02, cat C7, cat 08.

Abstract - A brief summary of the Bomvu Ridge iron ore deposit
with particular reference to opencast  mining at the Swaziland
Iron ore Development Co.  Ltd, the Ngwenya Mine, is made, and
the following  general aspects are covered: geology; mine staff;
 slope stability; changes in pit design; comparison of  pit
designs; planning; computers and planning; mining  operations;
plant; planned maintenance; future trends  in the iron ore
industry; and budgeting and costing.


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RANK =     22              - QL SYSTEMS LIMITED -         D=   9089  MNT

Publication Date - 780500
Title - Tailing, Canadian Regulations and Practice Marine
Disposal Systems.
Citation - World Mng, May 1978, 58-62, (Ref 4).
Accession Number - (CANMET) MNG18201
Accession Date - 780714
Keywords - cat 08, 1978, canada, far east, symposia, legislation
+ regulations, tailings, waste disposal, water, solids
pipelining, water pollution, water treatment, tailings ponds,
foundations, soils, data, sulphur, chemicals, ph.
Abstract - A summary is made of 3 papers on waste disposal of
tailings in Canada and of marine disposal presented at the 11th.
Commonwealth Mining and Metallurgical Congress held in Hong Kong
in 1978. They include Federal waste water controls for the
mining industry in Canada, Waste disposal and waste water
treatment to minimize environmental impact (sulphide wastes and
disposal on muskeg), and marine disposal of mine and mill
tailings with data on world cases.


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RANK = 23 - QL SYSTEMS LIMITED - D= 5061 MNT

Publication Date - 750000
Author(S) - Matarov VD, Tverdokhlebov IP and Kudryavtsev GI
Title - Conservation of Underground Waters When Working Anomaly Ore Deposits.
Citation - Gornyi Zhurnal, No. 6, 1975, 10-12.
Accession Number - (CANMET) MNG14144
Accession Date - 760725
Keywords - translations, russian language pubs, 1975, dewatering, iron ore mines + mining, soviet union, drainage, drawdown, ground water, cat 10.
Abstract - This translation from the original Russian discusses dewatering plans for a new iron ore mine in the Kursk Magnetic Anomaly region of Russia. Depressing the water table by up to 450 meters might have produced pollution of the potable water in the region because of mixing with brackish waters found at depth. Plans are to dewater primarily the brackish zone which is separated from potable water by impervious rocks and to backfill underground workings with hardening fill so as to reduce subsidence.

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RANK = 24 - QL SYSTEMS LIMITED - D= 2948 MNT

Publication Date - 730000
Title - Processes, procedures and methods to control pollution from mining activities.
Citation - Environmental Protection Agency, Wash., 1973, 390p, (215 Refs).
Accession Number - (CANMET) MNG12019
Accession Date - 750124
Keywords - 1973, control, procedures, water pollution, critiques and reviews, mines + mining, drainage, ground water, seepage, waste disposal, erosion, sealing, vegetative stabilization, land reclamation, neutralization, acids, extraction, water treatment, freezing, oxidation, bibliographies, costs, cat 08.
Abstract - Information is given on techniques of at source water pollution control applicable to both surface and underground mining including - pollution control planning for future surface mining, controlled mining methods, water infiltration control, handling pollution forming materials, waste water control, regrading, erosion control, revegetation, controlled mining procedures, water infiltration control, waste water control, mine sealing, neutralization processes, neutralization with limestone, and lime, sludge disposal, evaporation processes, reverse osmosis, electrodialysis, ion exchange processes, freezing, and iron oxidation.

BANK = 25 - GL SYSTEMS LIMITED - D= 24171 MNT

PUBLICATION DATE: 820000
AUTHOR(S): Kim AG, Heisey BS, Kleinmann RLP and Duel MH
TITLE: Acid mine drainage: control and abatement research. (Le drainage des mines acides: recherche sur la diminution et le controle des mines acides).
CITATION: U.S. Dept. of the Interior, Bureau of Mines Information Circular, IC 8905, 25pp., 38 ref., 1982.
ACCESSION NUMBER: CANMET MNG26196
ACCESSION DATE: 830916
ABSTRACT: A review is included of the acid mine drainage problem from underground coal mines and coal refuse piles in general as well as of research underway at the USBM to combat it. The research is orientated towards improving water treatment efficiency and developing low maintenance treatment systems. Areas of investigation are: improved iron oxidation efficiency, limestone neutralization, disposal of acid mine drainage sludge, and development of an artificial bog treatment system.
KEYWORDS: cat 08, 1982, united states, research programs, acids, drainage, control, coal mines + mining, dumps, water treatment, neutralization, oxidation, waste disposal, water pollution, bibliographies, underground mines + mining.

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BANK = 26 - GL SYSTEMS LIMITED - D= 20891 MNT

Publication Date - 811000
Author(S) - Ben-sin F and In-min C
Title - Experimental research work on the use of industrial waste products as antipirogenic agents for the prevention of fires breaking out in result of self-ignition of coal in collieries.
Citation - XII International Conference of Research Institutes in Safety in Mines, Katowice, Poland, Oct 1981, v. 2, B-6, 631-46, (Ref 4).
Accession Number - (CANMET) MNG22911
Accession Date - 811224
Keywords - cat 06, 1981, china, poland, symposia, safety, experimentation, fires, coal, coal mines + mining, underground mines + mining, spontaneous combustion, control, waste utilization, chemicals, materials, bibliographies.
Abstract - Based on lab. experiments chemical compounds such as calcium, magnesium, zinc and aluminum chlorides act as good inhibitors on brown and hard coal and water glass and slaked lime have similar effects on coal with a larger ferric sulphide content. Field experiments with industrial wastes in both brown and hard coal mines in China confirmed the good inhibiting properties of antipirogenic wastes. They can be used both in heated pillars and in multilayer longwall waste, are simple to use, and can be used in mines having a big fire hazard and a shortage of water and clay for silting. The chemical mechanism of the inhibiting agents is explained in terms of free radical chemistry, and the importance of their moisture retaining properties is cited.

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RANK =      27                 -  QL SYSTEMS LIMITED  -        D=  20549  MNT

Publication Date - 800100
Author(S) - Typliski EV and Labarre GJ
Title - Wastewater treatment at Hudson Bay Mining and Smelting
Co. Ltd, Flin Flon, Manitoba.
Citation - 12th Annual Meeting of the Canadian Mineral
Processors, Canada Centre for Mineral and Energy Technology,
Ottawa, Jan 1980, paper no. 8, 131-47, (Ref 2).
Accession Number - (CANMET) MNG22573
Accession Date - 810921
Keywords - cat 08, 1980, manitoba, ontario, symposia,
beneficiation, water treatment, neutralization, zinc mines
+ mining, separation, water pollution, control, waste disposal,
conservation, waste utilization, bibliographies.
Abstract - The company developed a 2-stage lime neutralization,
sludge recirculation and conventional mechanical thickening
process that treats 600 cubic m per day of wastewater containing
30-60 mg per l of zinc showing metal extraction efficiencies of
99 percent reducing it to 0.2-20 mg per l of zinc in the treated
effluent. Higher rates of 800 cubic m per day have resulted. The
slaked lime slurry is used to precipitate the heavy metal
hydroxide at a ph of 9.5-11, and while this stage of the process
successfully precipitated out iron and copper it showed little
separation efficiency for lead.

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RANK =      28                 -  QL SYSTEMS LIMITED  -        D=  13313  MNT

Publication Date - 680700
Author(S) - Rosenbaum JB and Dean KC
Title - Utilization and Stabilization of Solid  Mineral Wastes.
Citation - Proc of Eng Foundation Research Conf., Beaver  Dam,
Wisc., July 22-26, 1968, Preprint C-13, 4p.
Accession Number - (CANMET) MNG6469
Accession Date - 800521
Keywords - 1968, symposia, waste disposal, waste  utilization,
dust, leaching, extraction, tailings, construction, chemical
stabilization, vegetative  stabilization, united states, cat 08.
Abstract - This report reviews work in progress at  the Salt
Lake City Metallurgy Research Centre  on selected mineral waste
accumulations under  respective utilization and stabilization

categories.  Methods for recovering zinc and lead from foundry
flue dust include fuming, acid leaching, and acid or  ferrous
sulphate baking followed by water leaching.  Copper can be
precipitated from leach solutions  in which auto steel scrap is
tumbled. Sulphur, iron,  and copper can be recovered from
flotation mill  tailings by flotation and roasting. Bricks can
be  made from copper tailings and desulfied tailings  from two
sources. Sodium silicate, lime, lignin  sulfonates, redwood bark
extracts, amines,  acetate salts of amines, and other chemicals
are  effective chemical stabilizers. Research on  vegetative
stabilization at Utah State and the  USBM are mentioned
especially a method which  combines chemical and vegetative
stabilization.

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RANK =      29              - QL SYSTEMS LIMITED  -        D=  12098  MNT

Publication Date - 720000
Author(S) - Ikegami T
Title - Recent Practice of Waste Water Treatment at  Yanahara
Mine.
Citation - Print No.T-III-b-2, Joint Meeting Min Metall Inst Jpn
- Am Inst Min, Metall & Petrol Eng,  Tokyo, 1972, 10 p.
Accession Number - (CANMET) MNG7669
Accession Date - 800319
Keywords - waste disposal, water, drainage, oxidation,
neutralization, acids, sedimentary rocks, temperature, control,
water pollution, minerals, cat 08, japan, symposia, 1972.
Abstract - A report is made on a mine water  drainage treatment
operation at Yanahara mine. Major focuses are placed on ferrous
iron oxidation processes, iron-aluminum replacement, and two
stage  neutralization processes. Covered are: the history  of
the mine water treatment, the characteristics of  the mine
water, treatment practices of the A water,  and treatment
practices of the B water. Flowsheets  and data are included.

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RANK =      30              - QL SYSTEMS LIMITED  -        D=   4827  MNT

Publication Date - 740400
Title - Fifth Mines Branch Report on Environmental Improvement.
Citation - Canmet, Admin. Rep. 74-1, April 1974, 69p.
Accession Number - (CANMET) MNG13909
Accession Date - 760630
Keywords - 1974, canada, environment, dust, radon gas, measuring
instruments, noise, exhaust gases, coal, cat 08, engines

+ motors, vegetative stabilization, coal, washing, flocculants
+ flocculation, solids pipelining, sulphur, extraction, oil,
combustion, water pollution, research programs, experimentation,
erosion, tailings, waste utilization, energy, conservation,
heating, heat transfer, air pollution.
Abstract - The program for 1973 covers the mine environment
control program, diesel engine emissions, mine waste
revegetation, coal washing and flocculation, manufacture,
handling and transport of coke, desulpherization of oil before
combustion, sources of oil spills, weathering of mill tailings,
adsorption of trace amounts of metal ions by clay, recovery and
conversion of mineral wastes, pyrometallurgical process
modification and waste use, control of solid wastes from
metallurgical plants, control of effluent quality from
metallurgical plants by ion exchange, characteristics of pyrite,
fuel conservation, pollution control, efficient industrial
combustion systems, improving heat transfer efficiency,
dispersion of industrial plumes, energy penalties and
environmental constraints, and fuel efficiency in house oil
heating and energy from garbage and industrial waste.

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RANK = 31 - QL SYSTEMS LIMITED - D= 4235 MNT

Publication Date - 730300
Author(S) - Wilmoth RC and Hill RD
Title - Mine Drainage Pollution Control Via Reverse Osmosis.
Citation - Mining Engng., March, 1973, pp. 45-47.
Accession Number - (CANMET) MNG13317
Accession Date - 760525
Keywords - 1973, united states, desalination, cat 08, water treatment, drainage, water pollution, waste disposal.
Abstract - Neutralization and aeration removes acidity, iron and some other metals but does not remove soluble salts. Reverse osmosis (RO) removes many dissolved salts. RO is the flow of water through a semi-permeable membrane to leave dissolved salts behind while a pressure greater than osmotic pressure is applied to the solution (mine water from which Fi and Mn is to be retained by RO). Author discusses water recovery problems, iron fouling, membrane life, total system approach, and RO configurations.

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RANK = 32 - QL SYSTEMS LIMITED - D= 3069 MNT

Publication Date - 740400

Author(S) - Oko UM and Taylor WLG
Title - Treatment of acid mine wastewater at Falconbridges Hardy Crown pillar project.
Citation - CIM Bull., April 1974, 43-9, (2 Refs).
Accession Number - (CANMET) MNG12140
Accession Date - 750213
Keywords - 1974, acids, dewatering, overburden, cat 06, ground water, minerals, underground mines + mining, water pollution, wells, neutralization, water treatment, costs, bibliographies.
Abstract - A discussion is made of the dewatering of the overburden covering the orebody and the environmental control problems due to large quantities of dissolved iron and high acidity of the aquifer. Described are the Hardy orebody, the overburden, dewatering wells, water quality, treatment of waste water, water treatment plant, discharge of treated water, cost of treatment system, operations of the treatment plant.

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BANK =      33              - QL SYSTEMS LIMITED  -         D=  23539  MNT

PUBLICATION DATE:   821017
AUTHOR(S):          Poling GW, Revnitsev VJ, Pelletier CA,
                    Doyle EN, Leaton W  and Ellis DV
TITLE:              Round table seminar on submarine and lake
                    disposal of mill  tailings.
CITATION:           XIV International Mineral Processing
                    Congress- Worldwide  Industrial Application
                    of Mineral Processing Technology, Oct. 17-
                    23, 1982, Toronto, Ontario, Canada, p.X-1,
                    65pp., session X, 65  ref., 1982.
ACCESSION NUMBER:   CANMET MNG25563
ACCESSION DATE:     830420
ABSTRACT:           A set of key questions was answered in
                    preprint form by an  international panel of
                    experts.  The subject matter of the
                    questions were as follows: (1) environmental
                    conditions that  favour lake or marine
                    disposal rather than ponds; (2) factors
                    determining lock up of residual heavy metal
                    values in the  tailings solids; (3)
                    stabilization of heavy metal values
                    contained in tailings solids, the chemicals
                    and how they work,  and their cost; (4)
                    turbidity within the lighted or euphoric zone
                     and its prevention; (5) toxicity of milling
                    chemicals; (6)  prevention and control of
                    acid waters from lakes into which  oxidizable
                    sulphide-rich tailings are placed; (7)
                    localized  containment of solids in a
                    catchment basin vs. widespread  disposal over
                    the ocean bottom in marine disposal; (8)

                    experience  with this type of disposal; (9)
                    information sources on the  subject covering
                    environmental impacts, regulations, and legal
                     aspects; (10) effects on human health or on
                    important biological  resources; (11) capital
                    cost and operating cost for this type of
                    disposal vs. tailings ponds; (12) oxidation
                    and neutralization  treatments for acid
                    generating tailings into lakes, capital and
                    operating costs; (13) modelling; (14) impacts
                    on migratory  species and resident species as
                    well as on commercial fisheries;  and (15)
                    lab. tests to determine the potential hazards
                    of these  methods of tailings disposal.
KEYWORDS:           cat 08, 1982, canada, waste disposal, water,
                    solids pipelining,  symposia, tailings,
                    beneficiation, field investigations,
                    environment, toxicity, chemicals, health,
                    tailings ponds, costs,  neutralization,
                    oxidation, models, hazards, mines + mining,
                    bibliographies.

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RANK = 34 - QL SYSTEMS LIMITED - D= 22675 MNT

Publication Date - 810300
Author(S) - Jones AK, Johnson MS and Bell RM
Title - The control of metal dispersal in reclaimed land.
Citation - Min Mag, March 1981, 249-57, 5p, (Ref 15).
Accession Number - (CANMET) MMG24698
Accession Date - 821105
Keywords - cat 08, 1981, united kingdom, chemicals, land reclamation, control, minerals, pollution, tailings ponds, vegetative stabilization, mines + mining, bibliographies.
Abstract - The problems associated with the contamination of air, soil and water by heavy metals and consequent toxicity to animals and plants from metalliferous mining, smelting and refining are discussed with special reference to the U.K. Aspects covered include dispersal of toxic metals by water and wind erosion of wastes, prevention of dispersal by physical, chemical and especially vegetative stabilization, surface treatments with non-toxic amendments such as topsoil, subsoil, domestic refuse and sewage sludge, and acid generation by highly pyritic material. The strategies for the successful revegetation of metal contaminated land exist, but further research is needed on isolation of waste materials, weathering of tailings and pathways of metals into food chains.

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RANK = 35 - QL SYSTEMS LIMITED - D= 20588 MNT

Publication Date - 790000
Author(S) - Gorber DM, Ibbotson BG and Knapp RA
Title - Environmental considerations related to the mining and milling of uranium.
Citation - Management of Radioactive Wastes in Canada, Symposium, Toronto, 1981, Canadian Nuclear Association, Toronto, 19-34.
Accession Number - (CANMET) MMG22533
Accession Date - 810930
Keywords - cat 08, 1979, canada, symposia, management, waste disposal, radioactive isotopes, environment, uranium mines + mining, milling, pollution, control, chemicals, tailings.
Abstract - The aspects described are mainly based on experience with the Elliot Lake mines specifically tailings, the acid leach process and a pyrite bearing ore, and considerations are discussed relating to air and water pollution chemically and radioactively with aspects of monitoring and control mentioned for the long and short term effects.

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BANK =      36              - QL SYSTEMS LIMITED -        D=  20555  MNT

Publication Date - 800100
Title - Proceedings of the 12th Annual Meeting of the Canadian
Mineral Processors.
Citation - Canada Centre for Mineral and Energy Technology,
Ottawa, Jan 1980, 425p.
Accession Number - (CANMET) MNG22580
Accession Date - 810929
Keywords - cat 08, cat 05, 1980, ontario, symposia,
beneficiation, water treatment, waste disposal, land
reclamation, solids pipelining.
Abstract - Eight papers of interest from this conference are
water policy at Inco Metals Co. Mills Ontario Division, removal
of heavy metals from tailings recycle water at Mattabi Mines
Ltd., wastewater treatment at Hudson Bay Mining and Smelting Co.
Ltd., mine and tailings effluent treatment at the Kimberley,
B.C. operations of Cominco Ltd., acidic effluents, their
production and characteristics, aspects of tailings reclamation
in Ontario and Quebec, and slurry pump and pipeline performance
testing at Georgia Iron Works hydraulic laboratory.

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BANK =      37              - QL SYSTEMS LIMITED -        D=  11832  MNT

Publication Date - 780000
Author(S) - Edgeworth L, Cornwall GM and Scott JS
Title - Federal Waste-Water Controls for the Mining Industry in
Canada.
Citation - 11th. Commonwealth Mining and Metallurgical Congress.
Hong Kong, 1978, ed. M.J. Jones, 818p, 413-20.
Accession Number - (CANMET) MNG20419
Accession Date - 800303
Keywords - cat 08, 1978, far east, canada, symposia, legislation
+ regulations, zinc mines + mining, radioactive isotopes, lead
mines + mining, zinc mines + mining, copper mines + mining,
uranium mines + mining, iron ore mines + mining, mine
development, water pollution, toxicity, ecology, damages, ph,
control, sampling, water analysis, monitoring.
Abstract - Regulations and guidelines issued in March 1977 by
the Environmental Protection Service of the Canada Dept. of
Fisheries and the Environment for the control of liquid
effluents from base metal, uranium and iron ore mines and mills
are described. They are law for new, expanded or reopened
properties and guidelines for ongoing ones. Limits are
prescribed for arsenic, copper, lead, nickel, total suspended
solids, radium 226, zinc, acute fish toxicity, and pH. They
describe sampling, analytical and reporting requirements, and
the acute lethality test for fish companies to follow. The
efforts of the Wastewater Technology Centre and its program for
the development and demonstration of pollution control are
described.

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RANK = 38 - QL SYSTEMS LIMITED - D= 20843 MNT

Publication Date - 800800
Author(S) - Murray DR
Title - Water movement and contamination in and from sulphide uranium tailings related to surface treatment and abandonment.
Citation - Canada Centre for Mineral and Energy Technology, Canmet, Mining Research Lab., Report MRP-MRL 80-91, Aug 1980, 8p, (Ref 5).
Accession Number - (CANMET) MNG22862
Accession Date - 811203
Keywords - cat 08, 1980, canada, uranium mines + mining, tailings, water pollution, flow, sulphur, vegetative stabilization, gravels, materials, tailings ponds, ground water, chemical analysis, water analysis, bibliographies.
Abstract - A field lysimeter study was done to examine the influence of surface treatment (vegetation, gravel and sawdust) on effluent quality and quantity, and the effluent quality from tailings with most of the pyrite removed was investigated. The reaction processes are being studied and include both unsaturated and saturated zones. Differential movement of the contaminants from the tailings occurs, and a study will be made of the flow net pattern and of the correlation between profile solid content and water content for various contaminants. Problems with preliminary results are described.

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RANK = 39 - QL SYSTEMS LIMITED - D= 20795 MNT

Publication Date - 801200
Author(S) - Cherry JA, Blackport RJ, Dubrovsky N, Gillham RW and Lim TP
Title - Subsurface hydrology and geochemical evolution of inactive pyritic tailings in the Elliot Lake uranium district, Canada.
Citation - Canada Centre for Mineral and Energy Technology, Canmet, Mining Research Lab., Report MRP-MRL 80-121, Dec 1980, 34p, (Ref 9).
Accession Number - (CANMET) MNG22814
Accession Date - 811124
Keywords - cat 08, 1980, ontario, ground water, tailings, tailings ponds, uranium mines + mining, oxidation, acids, water analysis, chemical analysis, flow, seepage, water pollution, vegetative stabilization, field investigations, bibliographies.
Abstract - The oxidation of pyrite is causing pore water in the tailings at 3 sites to become acidic, and acidification has continued to occur in areas where the tailings are grass covered. Moderately acidic water with ph in the range 3-5 is common in the tailings, and more strongly acidic water of ph 1-3 was detected at only a few locations. Most of the pore water in the tailings has ph levels above 5. The rate at which acidic water replaces the original neutral water in the tailings depends on texture and pyrite content of tailings above the water table, hydrologic conditions beneath the tailings, hydraulic conductivity and degree of layering of the tailings, supply of water as rain and slope runoff to the surface of the tailings, and the type and density of vegetation established on the tailings surface.

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   RANK =      40              - QL SYSTEMS LIMITED -          D=  1753  MNT

   Publication Date - 731100
   Title - Destratification - a promising lake saver.
   Citation - Water and Pollution Control, Nov. 1973, 20.
   Accession Number - (CANMET) MNG10848
   Accession Date - 740619
   Keywords - 1973, water pollution, control, cat 08, compressed

  air, mixing, water supply, water, water treatment.
  Abstract - A method of controlling stagnant lake conditions is
  to install a source of compressed air in the water body and mix
  the water layers with it. In one case the mixing of the lake
  resulted in improved water quality re. hydrogen sulphide,
  dissolved oxygen, carbon dioxide, ammonia, nitrogen, total
  phosphorus and iron. Algal crops increased, secchi disk readings
  decreased, and zoo-plankton populations increased. Other cases
  of the beneficial effects of the process are cited.

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  RANK =      41              - QL SYSTEMS LIMITED -          D=  24528  MNT

  PUBLICATION DATE:   830315
  AUTHOR(S):          Datak T, Ger AM and Onder H
  TITLE:              An experimental study on hydraulic
                      transportation of a pyrite  ore.  (Une etude
                      experimentale sur le transport hydraulique du
                       mineral pyritique).
  CITATION:           Proceedings of the 8th International
                      Technical Conference on  Slurry
                      Transportation, March 15-18, 1983, San
                      Francisco, Cal.,  p.89, 8pp., 6 ref., 1983.
  ACCESSION NUMBER:   CANMET MNG26552
  ACCESSION DATE:     831017
  ABSTRACT:           A pilot plant study for predicting the head
                      loss and critical  deposition velocity of a
                      given solids-liquid mixture is a  requirement
                      for purposes of engineering design.  A study
                      was  undertaken to provide necessary data and
                      relationships to be used  in the design of a
                      prototype pipeline to transport iron-copper
                      pyrite ore in Turkey.  The relationships
                      developed and the tests  performed were aimed
                      at meeting the requirements of a client
                      company.
  KEYWORDS:           cat 05, 1983, near east, experimentation,
                      solids pipelining,  critical velocity,
                      slurries, water, data, design, iron ore mines
                       + mining, copper mines + mining,
                      bibliographies, pressures.

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RANK =     42              -  QL SYSTEMS LIMITED  -        D=   1752  MNT

Publication Date - 740300

Author(S) - Reid LC and Potworowski HS
Title - Ozone treats Arctic waters.
Citation - Water and Pollution Control, March 1974, 53-5.
Accession Number - (CANMET) MNG10847
Accession Date - 740619
Keywords - 1974, water supply, quality control, water treatment,
ground water, permafrost, minerals, experimentation, arctic
+ subarctic regions, cat 08.
Abstract - The use of ozone for iron, manganese organics and
color removal in cold waters is entirely feasible. Ozone may be
the answer to the need of better iron and manganese removal from
arctic water supplies. If the water is of acceptable hardness
after removal of iron and manganese the only treatment of the
raw water would be ozonation, sedimentation and filtration. The
resulting water would be free of odours and obnoxious tastes and
would be clear. A side benefit of the ozonation process would be
the purification.

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RANK =     43              -  QL SYSTEMS LIMITED  -        D=  16448  MNT

Publication Date - 790500
Author(S) - Garg C, Hetu G and Hindy D
Title - Twenty Five Year Experience in Dewatering at Canadian
Mining Complex.
Citation - 1st International Mine Drainage Symposium, Denver,
Colorado, ed. G.O. Argall and C.C. Brawner, May 1979, paper no.
18, 409-22, (Ref 12).
Accession Number - (CANMET) MNG21334
Accession Date - 801016
Keywords - cat 10, cat 03, 1979, united states, quebec province,
iron ore mines + mining, open pit mines + mining, dewatering,
drainage, excavation, water control, pumping, cold weather
operations, slopes, stability, water tables, freezing, wells,
bibliographies.
Abstract - The experience described is that of surface and
ground water control problems and measures at an iron ore open
pit mine at Schefferville, Quebec, Canada. The problems caused
by high rainfall and a high water table were unstable slopes,
high water content in the ore and transport problems on haulage
roads. Means of dewatering included surface drainage around the
pit, inpit and perimeter wells to lower the water table, and
precautions to prevent pipeline freezing in a subarctic climate.
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BANK = 44 - QL SYSTEMS LIMITED - D= 14738 MNT

Publication Date - 701000
Author(S) - Hill RD
Title - Limestone Treatment of Acid Mine Drainage.
Citation - Soc Min Eng, Am Inst Min Metall Pet Eng, Preprint No. 70-AG-332, Oct. 1970, 13 p.
Accession Number - (CANMET) MNG5102
Accession Date - 800730
Keywords - 1970, drainage, acids, neutralization, sedimentary rocks, physical properties, water pollution, control, procedures, cat 08.
Abstract - This preprint reports on the current state of the art treatment of acid mine drainage with respect to: chemical and physical properties of limestone, limestone selection, and the limestone treatment systems: low iron, ferric iron and ferrous iron acid mine drainage, and limestone-lime treatment.

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BANK = 45 - QL SYSTEMS LIMITED - D= 12951 MNT

Publication Date - 711000
Author(S) - Pence SA, McCallum AI and De Korompay V
Title - Water-Swellable Polymeric Sealant Protects Salt in Potash Shafts.
Citation - Can Min Metall Bull, Oct. 1971, pp 72-76, (Ref. 4).
Accession Number - (CANMET) MNG7175
Accession Date - 800505
Keywords - 1971, water, sealing, potash mines + mining, shafts, floods, control, saskatchewan, physical properties, pressures, costs, bibliographies, canada, cat 10, ground water, liners + lining.
Abstract - The Salt Protection Ring to work must eliminate formation of water migration into the salt formation; prevent any water pressure build up in a 24 in. concrete lining through the Prairie Evaporite formation; and prevent any deterioration of the concrete lining in the Evaporite which would be caused by movement of the formation waters. The basic concept of the application of the ring, the selection of the sealing material, design considerations, locations of the rings, saturation characteristics of the formation waters, construction of the rings, allowable pressure on the ductile cast iron tubbing ring, final closure of the shaft lining above the salt protection ring, and the installation costs are discussed.

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RANK =     46              - QL SYSTEMS LIMITED -         D=   8897  ANT

Publication Date - 740900
Author(S) - Haw VA
Title - Canadian U.S.S.R. Nonferrous Metals Working Group
Mission to the U.S.S.R.
Citation - Mines Branch, Ottawa, Sept. 20, 1974, 132p,
Accession Number - (CANMET) MMG18008
Accession Date - 780606
Keywords - cat 08, 1974, canada, symposia, visits, soviet union,
environment, gold mines + mining, water pollution, control,
tailings, water supply, water treatment, conservation, mills,
milling, water, waste disposal, neutralization, acids, sulphur,
tailings ponds, vegetative stabilization, land reclamation, zinc
mines + mining, copper mines + mining, air pollution, exhaust
gases, flow, seepage, beneficiation, dust collectors, heating,
heat, scrubbers.
Abstract - Papers presented at a joint symposium of Soviet
workers and members of a Canadian mission to the U.S.S.R. in
1974 on environmental problems associated with nonferrous
metallurgy are included as abstracts and in full in appendices.
Papers include environmental problems in the Canadian gold
mining industry, the use of closed cycle water supply systems at
the U.S.S.R. nonferrous metallurgy works, conditioning of
circulating water in the washery-water circuit of concentrating
mills in the nonferrous metals industry, storage of sulphide
bearing tailings, Ont., mine land reclamation research at
Cominco Ltd. operations in B.C., water treatment at Brunswick
no. 6 mine, methods for circulation of air contamination,
tailings disposal basin as waste water reclamation system and as
a possible source of pollution in water storage reservoirs,
emission of sulphur dioxide gas into the atmosphere from
nonferrous smelters, tunneltype waste heat boilers as coarse
dust collecting equipment, and fluorine, tar and dust collection
at aluminum electrolysis plants.


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RANK =     47              - QL SYSTEMS LIMITED -         D=   8326  ANT

Publication Date - 770600
Author(S) - Collings RK
Title - Mineral Waste Resources of Canada Report no. 2 Mining
Wastes in Quebec.
Citation - Canmet, M.R.L., 77-55, June 1977, 45p, (Ref 10).
Accession Number - (CANMET) MMG17425
Accession Date - 780116
Keywords - cat 08, 1977, quebec province, minerals, tailings,
data, statistics, waste (rock), physical properties, chemical
properties, waste utilization, mines + mining, construction,
waste disposal, aggregates, neutralization, acids, soils,
bibliographies.
Abstract - Data are provided on waste rock and mill tailings in
Quebec covering occurrence, mineralogy, and physical and

chemical properties for base metals, iron ore, precious metals,
and industrial minerals. Some of the potential uses of wastes
include fibre, mineral wool, construction aggregates, building
brick, neutralizer for acid soils and plant wastes, and
refractory grade magnesia.


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RANK = 48 - CL SYSTEMS LIMITED - D= 7557 MNT

Publication Date - 740000
Author(S) - Hicks FJ
Title - The Iron Ore Industry of Western Labrador and Some Effects of its Waste Disposal Practices on the Aquatic Environment.
Citation - Environ. Canada, Surveillance Rep. EPS-5-ar-74-2, 106p,(Ref 40).
Accession Number - (CANMET) MNG16650
Accession Date - 770728
Keywords - cat 08, 1974, newfoundland + labrador, iron ore mines + mining, waste disposal, environment, mills, milling, tailings, water pollution, water, field investigations, chemical analysis, toxicity, ecology, bibliographies.
Abstract - A description is made of mining and milling at iron ore mines on western Labrador and of the effects of tailings disposal on the water quality and biology of Wabush Lake. Reference is made to earlier toxicity, sedimentological and water quality studies, and changes since the present. Age and growth of lake whitefish, benthic macroinvertebrates, and primary productivity were investigated.

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RANK = 49 - CL SYSTEMS LIMITED - D= 3589 MNT

Publication Date - 741100
Author(S) - Russe E
Title - Acid Drainage Control and Water Treatment at Heath Steele.
Citation - CIM Bull., Nov. 1974, 54-61.
Accession Number - (CANMET) MNG12667
Accession Date - 751104
Keywords - cat 08, 1974, new brunswick, lead mines + mining, zinc mines + mining, toxicity, legislation + regulations, water pollution, water control, drainage, mill tailings, pumping, water analysis, planning, tailings ponds, capital costs, operating costs, standards, milling, pumps, water treatment, acids, water, environment.

Abstract - Heath Steele Mines Limited in New Brunswick operate a 3,000-tpd mine and concentrator and produce lead, zinc, and copper flotation concentrates from complex massive sulphide ores. The problem of acid drainage is caused by underground and surface water contacting metal sulphides, becoming acid and acquiring dissolved heavy metals. In sufficient concentrations, these metals are toxic to fish life. To meet government requirements, a comprehensive water pollution abatement program was started early in 1970 and became fully operational by the fall of 1972. Contaminated surface drainage with all water from underground workings is mixed with mill tailings and hydrated lime to precipitate the dissolved metals. The program has substantially improved the water quality in the affected streams.

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RANK = 50 - QL SYSTEMS LIMITED - D= 24014 MNT

PUBLICATION DATE: 810600
AUTHOR(S): Gordienko NM
TITLE: The combined storage of concentration tailings and overburden.
CITATION: Canada Trans. Bur., Transl. n.004768, Transl: Gornyi zhurnal, n.6, June 1981, 3 ref., pp.23-6, 19pp.,
ACCESSION NUMBER: CANMET MNG26039
ACCESSION DATE: 830715
ABSTRACT: A technology was developed in the Soviet Union to reduce the combined amount of wasted land area due to separate dumping of iron ore open pit overburden and tailings from the concentrators. In this system overburden waste is dumped onto the tailings repositories as the latter fill up. Feasibility studies have confirmed that the combined storage of tailings and overburden is practical for the iron ore complex. This system is technically simple and reduces the cost of storing the tailings and overburden. It is also an important environment conservation measure enabling the curtailment of the amount of land assigned to dumps and ponds, reduces the amount of dust associated with the tailings ponds, and reduces the amount of water involved in tailings storage alone.
KEYWORDS: cat 08, 1981, soviet union, storage, tailings, overburden, dumps, tailings ponds, waste disposal, iron ore mines + mining, open pit mines + mining, bibliographies.

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RANK = 51 - QL SYSTEMS LIMITED - D= 21739 MNT

Publication Date - 780700
Author(S) - Huck PM and Leclair EP
Title - Treatment of base metal mine drainage at pilot scale.
Citation - Fisheries and Environment Canada, Water Pollution Control Directorate, Technology Development Report EPS 4-wp-78-4, July 1978, 95p, (Ref 22).
Accession Number - (CANMET) MNG23760
Accession Date - 820603
Keywords - cat 08, 1978, new brunswick, water treatment, drainage, lead mines + mining, zinc mines + mining, copper mines + mining, acids, water pollution, control, neutralization, filtration, bibliographies, flocculants + flocculation.
Abstract - The suitability of conventional precipitation and sedimentation to remove lead, zinc, copper and iron from various kinds of acid mine drainage was investigated in New Brunswick. The 0.3-1.0 litres per s pilot plant was designed for lime, and polymer addition, flocculation, clarification, filtration, and sludge recycle. Optimum operating ranges were determined for individual unit processes and data on attainable levels of extractable and dissolved metals are presented. Experiments were done to compare 2-stage lime neutralization to single-stage lime neutralization and to investigate sludge dewaterability and effluent toxicity.

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RANK =     52              -  QL SYSTEMS LIMITED  -         D=  21127  MMT

Publication Date - 790000
Author(S) - Jones H and Loo B
Title - In-pit dust control at Mt. Whaleback, Newman, West
Australia.
Citation - Western Australia Conference, 1979, Australasian
Institute of Mining and Metallurgy, 35-42, (Ref 4).
Accession Number - (CANMET) MMG23150
Accession Date - 820212
Keywords - cat 06, cat 08, 1979, australia, symposia, open pit
mines + mining, iron ore mines + mining, dust control, water,
drilling, loading, haulage, sprayers, roads, waste disposal.
Abstract - Dust problems associated with drilling, loading,
hauling and dumping are described indicating the large amounts
of water used. Methods in use include spraying of haulroads,
wind blown dust is reduced by application using water cannons of
large amounts of water to floor stocks prior to loading and
installation of automatically controlled fixed sprinkler
reticulation on the main semi-permanent haulroads. The methods
used to assess the water requirements for in pit dust
suppression are discussed and the extensive development testing
used to evolve the present installations are described.


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RANK =     53              -  QL SYSTEMS LIMITED  -         D=  19416  MMT

Publication Date - 641200
Author(S) - Kolbe H
Title - Hydrogeological Problems in the Salzgitter Iron  Ore
Area.
Citation - Z dt Geol Ges, Hanover, Vol. 116, Pt. 1,  Dec. 1964,
pp 141-159 (ref 20) (German Text).
Accession Number - (CANMET) MMG651
Accession Date - 810209
Keywords - 1964, west germany, german language pubs, iron ore
mines + mining, mine geology, ground water, water control, water
supply, cat 10.
Abstract - The author discusses the geol.  characteristics of
the Fe ore area in and around  Salzgitter, the hydrolog.
characteristics of  the ground waters, the influence of the min.
methods  on water supply and the utilization of ground water  in
ore dressing.

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RANK =      54              - QL SYSTEMS LIMITED -         D=  16617  MNT

Publication Date - 691200
Author(S) - Mihok EA
Title - Mine Water Research: Catalytic Oxidation of  Ferrous
Iron in Acid Mine Water by Activated  Carbon.
Citation - US Bur Mines Rep Invest 7337, Dec. 1969, 7p.  (ref
3).
Accession Number - (CANMET) MNG3031
Accession Date - 801021
Keywords - 1969, water analysis, mines + mining, oxidation,
neutralization, quality control, acids, data, cat 08.
Abstract - Lab. batch-flow tests conducted on a  highly
ferruginous acid mine water with an  activated C showed that
ferrous Fe is rapidly  oxidized. This indicates that air
oxidation of  ferruginous acid in mine waters is catalyzed by
activated C. The ferrous Fe content of an acid  mine water
flowing through an aspirated activated C  column was reduced
from 700 to 10 ppm in < 1 minute.

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RANK =      55              - QL SYSTEMS LIMITED -         D=  14682  MNT

Publication Date - 710400
Author(S) - Sevoir EC and Belanger GH
Title - Environmental Control at Sherman Mine, Temagami,
Ontario.
Citation - 73 Annual General Meeting, Can Inst Min Metall,
Quebec City, April 25-28, 1971, Preprint No. 62,  10 p.
Accession Number - (CANMET) MNG5238
Accession Date - 800730
Keywords - 1971, symposia, quebec province, ontario, water
pollution, control, waste disposal, water supply, mining
research, iron ore mines + mining, tailings ponds, vegetative
stabilization, blasting, monitoring, cat 08.
Abstract - This preprint describes the environmental control
program at the Sherman Mine, Temagami,  Ontario. A closed water
recirculation system using  four small lakes is described, and
details on  pollution control, dam construction, sampling, and
revegetation are given. A study program concerning  a system of
mill waste tailings and storage, the  application of soil
mechanics principles to the  storage of tailings, revegetation,
and the ecology of  the water system is outlined.

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RANK = 56 - QL SYSTEMS LIMITED - D= 14644 MRT

Publication Date - 800500
Author(S) - Burton A, Koenig R, Crocker C, Trexler B and Kim Y
Title - Mining- Technological Achievements Mark the Decade.
Citation - Min Eng (NY), May 1980, 518-32, (Ref in text).
Accession Number - (CANMET) MNG21058
Accession Date - 800728
Keywords - cat 04, cat 08, cat 02, cat 39, cat 06, cat 03, 1980, united states, mines + mining, critiques and reviews, mine development, drilling, blasting, haulage, land reclamation, mining methods, shaft sinking, ground water, roof control + ground support, leaching, rock mechanics, computers, waste disposal, safety, accidents, bibliographies.
Abstract - A general review is made of developments in open pit and underground mining in the U.S. and elsewhere for the year 1979 based on journal papers and articles from symposia referring to the following topics- open pit mines- large copper mine in Mexico, surface clay pit mining methods, Mesabi iron ore range expansions, tar sand operations in Alberta, mine planning with computers, rotary drills in the pit, blasting, automatic truck control, restoration and waste disposal, and dipper maintenance, underground mining- energy audits and saving plans, underground mining of oil shale, hydraulic drills, blindhole raise boring, a ground support system for grizzly and haulage drifts, ground water hydrology- ground investigations, laws, and cases of water pollution, in situ leaching of uranium, ground control- subsidence, computers and rock mechanics, satellites and ground monitoring, underground disposal of nuclear waste, and cable bolting, and safety and health with accident data.

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RANK = 57 - QL SYSTEMS LIMITED - D= 13364 MNT

Publication Date - 800200
Author(S) - Murray DR
Title - Surface Stabilization- Waste Management Demonstration Study and Progress Report 1978-9.
Citation - Canada Centre for Mineral and Energy Technology, Mining Research Lab., MRP MRL Report 80-12, Feb. 1980, 31p. (Ref 2).
Accession Number - (CANMET) MNG20741
Accession Date - 800523
Keywords - cat 08, 1980, canada, confid, tailings, tailings ponds, field experimentation, acids, vegetative stabilization, uranium mines + mining, sulphur, seepage, ground water, water pollution, bibliographies.
Abstract - A field demonstration project involving Canmet and the mining company on the vegetative stabilization of uranium tailings containing sulphide is described that was successful for large scale implementation. A description is given of the recommended method in a field situation as well as some hydrologic and chemical studies of seepage water draining into surrounding ground water and streams. Seeding, fines and equipment use problems are described.

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RANK = 58 - QL SYSTEMS LIMITED - D= 12518 MNT

Publication Date - 790000
Author(S) - Burchfield TE and Hepler LG
Title - Some Chemical and Physical Properties of Produced Water from an In Situ Oil Sands Plant.
Citation - In Situ, v. 3, no. 4, 1979, 383-90, (Ref 12).
Accession Number - (CANMET) MNG20531
Accession Date - 800417
Keywords - cat 08, cat 10, 1979, alberta, chemical analysis, water, conservation, water pollution, waste disposal, extraction, oil sands, in situ, chemical properties, physical properties, separation, concentrating, tension, bibliographies.
Abstract - An analysis was made of process water from an oil sands extraction plant near Fort McMurry, Alberta, Canada to obtain data about substances dissolved or suspended in this water and about its surface tension dependence on pH in relation to either disposal of the water or recycling of it. Major soluble inorganics determined were sodium, calcium, chloride, and sulphate ions, and lower concentrations of other ions were found including potassium, magnesium, aluminum, iron and silicon. Soluble organics exhibit surfactant properties as shown by the surface tension vs. pH relation- the hydrogen ion concentration tending to decrease the surface tension strongly.

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RANK = 59 - QL SYSTEMS LIMITED - D= 12403 MNT

Publication Date - 710800
Author(S) - Ahmad M
Title - Proceedings of Acid Mine Drainage Workshop, August 2-August 6, 1971, Ohio University, Athens, Ohio.
Citation - Proc Acid Mine Drainage Workshop, Ohio University Workshop, Athens, Ohio, August 2-6, 1971, 167 p.
Accession Number - (CANMET) MNG7378
Accession Date - 800411
Keywords - 1971, acids, drainage, symposia, united states, land reclamation, open pit mines + mining, velocity, oxidation, sulphur, sealing, underground mines + mining, control, water pollution, legislation + regulations, dumps, chemicals, chemical analysis, water, monitoring, rocks, soils, overburden, bibliographies, cat 08.
Abstract - Contents: (1) Strip Mine Reclamation Reform. (2) Rate of Pyrite Oxidation and Acid Production in the Field. (3) Deep Mine Sealing. (4) Hydrological Approach to Control Acid Pollution. (5) Acid Mine Drainage Abatement in Ohio. (6) The Legal Framework of Acid Mine Drainage Control. (7) Mine Drainage Controls by the Ohio River Valley Sanitation Commission. (8) Kentucky Land Reclamation. (9) Acid Mine Drainage Abatement Programs in Surface Mining. (10) Reclamation of Toxic Spoilbanks. (11) Chemical Analysis of Mine Water. (12) Mine Drainage Monitoring. (13) Identification of Pyrite in Rocks. (14) Principles Influencing the Usefulness of Chemical Testing of Mine Spoils. (15) Soil Profiles Before and After Surface Mining. (16) Properties of Overburden Materials Related to Spoil Bank Chemistry.

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BANK =     60            - QL SYSTEMS LIMITED -         D=  12219  MNT

Publication Date - 711200

Author(S) - Rivett LS and Oko UM
Title - Tailings Disposal, Generation of Acidity from
Pyrrhotite and Limestone Neutralization of Waste  Water at
Falconbridge Onaping Mines.
Citation - Deco Trefoil, Winter Issue, 1971-1972, pp 9-16,
(Ref. 12).
Accession Number - (CANMET) MNG7117
Accession Date - 800321
Keywords - 1971, 1972, tailings, waste disposal, acids,
sedimentary rocks, neutralization, water pollution, dikes +
dams, data, bibliographies, canada, ontario, copper mines +
mining, nickel mines + mining, cat 08.
Abstract - The water pollution problem associated  with the
mining and treatment of sulphide ores that  had to be resolved
was that of controlling acid  formation. A dam and a Spillway
were constructed to  introduce a continuous stream of finely
ground  limestone pulp to neutralize the acidity. The  limestone
neutralization unit was designed to operate  continuously and
unattended. The system has operated  satisfactorily over the
past several years producing  good quality neutral water at flow
rates varying from  6,000-30,000 gpm(spring runoff).

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BANK =     61            - QL SYSTEMS LIMITED -         D=  12008  MNT

Publication Date - 720000
Author(S) - Shumate KS and Smith EE
Title - Analysis of Mine Sealing Alternatives.
Citation - Print No. I-II-c-3, Joint Meeting Min Metall  Inst
Jpn - Am Inst Min, Metall & Petrol Eng,  Tokyo, 1972, 11 p.
(Ref. 6).
Accession Number - (CANMET) MNG7648
Accession Date - 800313
Keywords - chemical analysis, sealing, acids, drainage,
oxidation, sulphur, control, underground mines + mining, flow,
bibliographies, moisture, water pollution, air, symposia, 1972,
cat C6.
Abstract - A framework is given for the rational  analysis and
design of methods for the at-source  control of acid mine
drainage of underground mines.  The Ideas presented have an
application to both  existing and proposed mining situations,
and is  described for Appalachian bituminous coal mines in
which reduced metal sulphides are exposed to the  oxidizing
influence of the air. Included are: the  chemistry of acid mine
drainage formation, physical  characteristic of natural pyritic
systems, rates of  oxidation of these systems, rate of acid
production,  mine sealing alternatives, flow diversion, and the
future of mine sealing.

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RANK =     62              - QL SYSTEMS LIMITED  -        D=  11407  MNT

Publication Date - 710900
Author(S) - Bergmann A
Title - How Meggen Purifies Mine Water and Recovers  Marketable
Zn Precipitate.
Citation - World Min, September 1971, pp 48-51.
Accession Number - (CANMET) MNG8037
Accession Date - 800125
Keywords - 1971, water pollution, control, costs, storage,
ground water, waste disposal, underground mines + mining,
minerals, extraction, chemicals, neutralization, filtration,
dewatering, west germany, cat 08.
Abstract - A unique system for purifying mine water  with a high
degree of metallic contamination is in  operation at the Meggen
mine in West Germany. The  process yields clean water for
discharge into a river  and saleable metal concentrates. The
precipitation  process involves additions of lime, quicklime and
 chlorine to raise the pH to basicity and precipitate  iron,
manganese and zinc as hydroxides. These are  further processed
with flotation products. Described  are: ground water
percolation, the rejection of  tailings ponds, the process of
precipitation, the  reagents, filtering and drying residues, and
a cost  comparison of two systems of processing.

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RANK =     63              - QL SYSTEMS LIMITED  -        D=   9830  MNT

Publication Date - 781200
Author(S) - Klohn E and Dingeman D
Title - Tailings Disposal System for Reserve Mining Co.
Citation - World Mng, Dec. 1978, 46-51.
Accession Number - (CANMET) MNG18950
Accession Date - 790329
Keywords - cat 08, 1978, united states, iron ore mines + mining,
tailings, waste disposal, open pit mines + mining, legislation
+ regulations, standards, tailings ponds, case histories,
design, monitoring, environment.
Abstract - Waste disposal facilities and design of an iron ore
mining co. in the Mesabi iron range of Minnesota are described
where strict legal controls exist and the facilities involve a
tailings basin, a closed water system, thickeners, dry cobbing
process, classification of coarse tailings, coarse tailings
filtering, conveying, haulage and storage, and pumping of fines.

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RANK =      64                - QL SYSTEMS LIMITED  -          D=   6904  MNT

Publication Date - 761000
Title - Hydro-mining in West Germany.
Citation - Eng Mag., Oct. 1976, 344-5.
Accession Number - (CANMET) MMG15741
Accession Date - 770614
Keywords - cat 04, cat 05, 1976, west germany, field
investigations, underground mines + mining, mining research,
water jet drills and drilling, conveyors, coal, coal mines
+ mining, waste (rock), hydraulic hoisting, water, conveying,
pumping, slurries, hydraulic equipment, feeders, feeding,
cutting, materials handling.
Abstract - Field trials in the production, conveying and
hoisting of ore, coal and waste rock in underground coal mines
in West Germany are summarized with reference to water jet
cutting, collection, removal of tramp wood or iron, crushing,
screening and water conveyence to a bunker system, pipe feeder
system, and results.

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RANK =      65                - QL SYSTEMS LIMITED  -          D=   5239  MNT

Publication Date - 740900
Author(S) - Convey J and Haw V
Title - Canadian U.S.S.R. Non-ferrous Metals Working Group
Mission to the U.S.S.R.
Citation - Mines Branch, Ottawa, Sept. 1974, 126p.
Accession Number - (CANMET) MMG14322
Accession Date - 760826
Keywords - cat 08, 1974, canada, soviet union, visits,
environment, control, symposia, pollution, tailings, water,
tailings ponds, waste disposal, land reclamation, water
treatment, storage.
Abstract - Papers of interest include - environmental problems
in the Canadian gold mining industry, conditioning of water
circulating in the washery water circuit of concentrating mills
in the non-ferrous metal industry, storage of sulphide bearing
tailings in Ontario, Canada, mined land reclamation at Cominco,
B. C., water treatment at Brunswick mining and Smelting Corp
Ltd., and a tailings disposal basin as a waste water reclamation
system and as a possible source of water storage reservoirs
pollution.

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RANK = 66 - QL SYSTEMS LIMITED - D= 5000 MNT

Publication Date - 751100
Author(S) - Collings RK
Title - Mineral Waste Resources of Canada, Rep. 1, Mining Wastes in Ontario.
Citation - Canmet, Miner. Res. Prog., 76-2, Nov. 1975, 44p, (Ref 7).
Accession Number - (CANMET) MMG14083
Accession Date - 760721
Keywords - cat 10, 1975, ontario, waste disposal, waste utilization, reserves, tailings, data, waste (rock), particle size, ph, geology, mines + mining, bibliographies, tailings ponds.
Abstract - Basic background information on mining and mineral processing wastes in Ontario is given on base metal mines, iron, precious metal, industrial mineral and uranium mines. Data is given on companies re. location, type of operation, geology and ore mineralogy, and on tonnage, size, ph, density, plus current or potential use, for both rock and mill tailings waste.

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RANK = 67 - QL SYSTEMS LIMITED - D= 2243 MNT

Publication Date - 720500
Title - Fly ash collection provides raw material for ersatz cement.
Citation - Water and Pollution Control, May 1972, 57-8.
Accession Number - (CANMET) MMG11336
Accession Date - 740911
Keywords - 1972, fly ash, electric power generation, electrostatic precipitation, cements, construction, waste disposal, waste utilization, beneficiation, dust control, fines, minerals, cat 08.
Abstract - The Lakeview plant processes about 1/2 of the fly ash waste from a coal burning plant and has a design capacity of producing up to 140,000 tons of lightweight aggregate, 40,000 tons of pozzolan, and about 20,000 tons of powered iron oxide yearly from 200,000 tons of fly ash. The plant involves 3 processes - pozzolan, iron oxide and carbon are extracted, in the sintering process the material is pelletized by the addition of exactly controlled amounts of water, and the pellets are predried and led to a furnace. For use in precaste concrete products, the pellets are crushed, graded into various sizes and stored.

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RANK =      68              - QL SYSTEMS LIMITED -         D=   2076  ANT

Publication Date - 720000
Author(S) - Holmes J and Kreusch E
Title - Acid mine drainage treatment by ion exchange.
Citation - Environ. Prot. Agency, Cincinn., Ohio, 1972, 177p,
(refs page 169).
Accession Number - (CANMET) MNG11169
Accession Date - 740729
Keywords - 1972, acids, drainage, extraction, cat 08,
experimentation, chemicals, water pollution, control,
bibliographies, ph.
Abstract - Laboratory studies were done on synthetic acid mine
drainage treatment using ion exchange processes. In the first
part 5 ion exchange resins of various types commercially
available were surveyed through laboratory column tests to
determine their applicability in the treatment of acid mine
drainage. In the second part the 3 resins that were feasible in
the treatment of drainage from the first part were studied. They
were studied in the treatment of drainage containing 100 percent
ferrous iron, and in separate tests 100 percent ferric iron and
a total process for the production of potable water.

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RANK =      69              - QL SYSTEMS LIMITED -         D=   1137  ANT

Publication Date - 730100
Author(S) - Vimmerstein JP, Finney JH and Sutton P
Title - Effect of strip mining on water quality.
Citation - Water Resources Centre, Ohio State Univ., Ohio, Jan.
1973, 54p, (16 Refs).
Accession Number - (CANMET) MNG10213
Accession Date - 740205
Keywords - 1973, open pit mines + mining, chemical analysis,
water, water pollution, minerals, acids, flow, velocity,
erosion, field investigations, moisture, density, dumps, waste
disposal, United States, coal mines + mining, cat 06.
Abstract - The effect of strip mining on water quality of Little
Mill Creek, Ohio and the infiltration of water on strip mine
spoil banks are described. Chemical water quality in the Creek
was measured for 236 weeks. Sulphate, manganese, calcium,
magnesium, iron, aluminum, and hydrogen ion concentration were
measured.

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RANK =     70              -  QL SYSTEMS LIMITED  -        D=   1117  EST

Publication Date - 730000

  Author(S) - Bayazeed AF, Donaldson EC and US Bureau Mines
  Title - Subsurface disposal of pickle liquor.
  Citation - U.S.B.M., Rep. Invest. 7804, 1973, 31p, (13 Refs).
  Accession Number - (CANMET) MMG10193
  Accession Date - 740205
  Keywords - 1973, waste disposal, wells, fluids, acids, water,
  sensitivity, absorption + adsorption, neutralization,
  bibliographies, storage, cat 08.
  Abstract - The injection of waste pickle liquor into a sandstone
  formation for almost 10 years has proved the feasibility of this
  method of disposal. After a long period of storage, most of the
  acid in the liquor will be neutralized and the iron irreversibly
  adsorbed by the geologic formation. Subsurface disposal of this
  waste is a pollution abatement process since the impact on the
  environment is considerably less than that of land fill or
  stream discharge.

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RANK =     71              -  QL SYSTEMS LIMITED  -        D=  23381  EST

  PUBLICATION DATE:    820000
  AUTHOR(S):           Guertin JD and Flanagan RF
  TITLE:               Effect of artesian aquifer on feasibility of
                       Buffalo LRRT  project.
  CITATION:            Tunnelling '82, p.121, 5pp., 1982.
  ACCESSION NUMBER:    CANMET MMG25405
  ACCESSION DATE:      830322
  ABSTRACT:            The feasibility of constructing rock tunnels
                       for the Buffalo  LRRT project was seriously
                       threatened by the discovery of a  fractured
                       rock artesian aquifer immediately beneath
                       3.2km of the  proposed tunnels.  Detailed
                       innovative investigations, including  many
                       test borings plus drilling of large diameter
                       exploratory  shafts and test wells with
                       subsequent pump testing, demonstrated  the
                       feasibility of controlling groundwater
                       inflows from the  aquifer during tunnel
                       construction.  The dewatering system as
                       constructed included 5 mandatory plus 5
                       supplemental wells.  The  system adequately
                       controlled groundwater except in 1-91m
                       section  where an unexpected aquifer was
                       encountered that necessitated the
                       installation of 2 additional deep wells.  The
                       requirement for a  treatment plant to
                       eliminate hydrogen sulphide and to increase
                       dissolved oxygen levels prior to discharge
                       into surface waters  was an additional
                       feature of the project.
  KEYWORDS:            cat 09, cat 10, 1982, united states,

                       tunnelling, ground water,  wells, water
                       control, drilling, dewatering.

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RANK = 72 - QL SYSTEMS LIMITED - D= 21973 HRT

Publication Date - 801100
Author(S) - Klohn EJ and Dingeman D
Title - Tailings disposal system for Reserve Mining Co.
Citation - Proc Seminar, Golden Col. Nov, 1980, Design and Construction of Tailings Dams, ed. D. Wilson, July 1981, 161-8, 7p.
Accession Number - (CANMET) MMG23998
Accession Date - 820719
Keywords - cat 08, 1980, 1981, united states, symposia, design, construction, tailings, dikes + dams, waste disposal, iron ore mines + mining, tailings ponds, air pollution, fibrous dust.
Abstract - The stringent conditions imposed by law on this taconite operations dumping of tailings into Lake Superior and its requirement to construct and monitor the operation of a tailings pond are described. Permit conditions are listed, and the technology required- operation as a closed system including collection of seepage and surface runoff for return to the basin, a dual pipeline system with required controls, spill detection devices, emergency catchment basins, and treatment of any water discharge to water quality standards.

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RANK = 73 - QL SYSTEMS LIMITED - D= 21915 HRT

Publication Date - 771000
Author(S) - Williamson F and Cohen DC
Title - The optimization of filtered and unfiltered Ra(226) removal from uranium mining effluents status report (1976-7).
Citation - Canadian Uranium Producers Metallurgical Committee Workshop on Ra(226) Control, Oct 1977, Ottawa, 20p, (Ref 7).
Accession Number - (CANMET) MMG23937
Accession Date - 820629
Keywords - cat 08, 1977, ontario, symposia, optimization, filtration, radioactive isotopes, uranium mines + mining, water pollution, waste disposal, laboratory experimentation, chemicals, clays.
Abstract - Laboratory experiments were done to determine the effectiveness of using organic polymers and/or inorganic flocculants including high iron acid seepage to increase the settling rate of Ra BaSO(4) precipitate. Large improvements in settleability were demonstrated using ferric chloride or alum with effluents from uranium mines in the Elliot Lake and Beaverlodge areas. No improvements were noted when polymers, ferric sulphate, clay or soaps were used alone or in conjunction with other flocculants.

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RANK =     74            - QL SYSTEMS LIMITED -          D= 21142  NRT

Publication Date - 791000
Author(S) - Watkin EM
Title - Aspects of mine waste reclamation in central Canada.
Citation - Reclamation of Contaminated Land, Eastbourne,
England, Oct 1979, Society of Chemical Industry, London, 1980,
C10, 1-9, (Ref 9).
Accession Number - (CANMET) MNG23165
Accession Date - 820212
Keywords - cat 08, 1979, ontario, quebec province, land
reclamation, symposia, nickel mines + mining, tailings, case
histories, copper mines + mining, uranium mines + mining, acids,
vegetative stabilization, asbestos mines + mining,
bibliographies.
Abstract - Case histories are summarized of the vegetative
stabilization of various metal tailings in Provinces of Ontario
and Quebec stressing problems of acids, amendments, vegetative
data, and degree of success for the following cases, which are
keyed to the references- wastes containing iron sulphides
(nickel tailings at Copper Cliff, copper tailings at Noranda,
uranium tailings at Elliot Lake), and asbestos tailings in
Quebec.

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RANK =     75            - QL SYSTEMS LIMITED -          D= 19996  NRT

Publication Date - 810200
Author(S) - Witherspoon PA, Cook NGW and Gale JE
Title - Geologic Storage of Radioactive Waste- Field Studies in
Sweden.
Citation - Science, v. 211, Feb 1981, 894-900, (Ref 24).
Accession Number - (CANMET) MNG22016
Accession Date - 810416
Keywords - cat 03, cat 08, 1981, sweden, geology, subsurface
waste disposal, radioactive isotopes, displacements, iron ore
mines + mining, subsurface structures, fractures, igneous rocks,
ground water, mechanical properties, field experimentation,
heat, heat transfer, rock mass.

Abstract - Underground experiments were done in a granitic rock
mass in an iron ore mine in Sweden to investigate the
hydrogeology- the extent of fracturing and ground water
contamination possibilities, and the difficulties of predicting
the thermo-mechanical behavior of fractured granitic rocks-
heating experiments. To characterize a site fully surface
measurements must be supplemented by extensive subsurface
investigation, and problems are summarized.

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RANK =      76              -  QL SYSTEMS LIMITED  -         D=  19926  MNT

Publication Date - 810100
Author(S) - Courtney WG
Title - Preventing Frictional Ignitions.
Citation - Coal Min Process, Jan 1981, 48-58, 6p only, (Ref 23).
Accession Number - (CANMET) MMG21946
Accession Date - 810406
Keywords - cat 06, cat 04, 1981, united states, coal mines +
mining, underground mines + mining, cutting, rocks, explosions,
methane gas, coal dust, laboratory experimentation, control,
protection, mining machinery, rock picks, friction, detonation,
bibliographies.
Abstract - Frictional ignitions caused by rock cutters on miners
or tunnelling machines cutting into hard quartzite or pyritic
material can lead to methane gas-coal dust explosions in coal
mines and keyed to the literature a review is made of laboratory
research on the formation of flammable mixtures, ignition of
flammable mixtures, ignition quenching and face inerting. The
qualitative state of research on this subject and of means for
its prevention are stressed and outlined including replacement
of worn or broken bits, maintaining bit rotation, use of a
supertough bit tip, wet heads, use of water sprays, control of
advance rate, lowered bit speed, spray-fan systems, mechanical
diffuser fans, secondary exhaust ventilation, methane drainage,
water infusion, increased primary ventilation, ignition
quenching device, and inerting.

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RANK =      77              -  QL SYSTEMS LIMITED  -         D=  19604  MNT

Publication Date - 730700
Author(S) - Caruccio FT
Title - Estimating the Acid Potential of Coal Mine Refuse.
Citation - Ecology of Resource Degradation and Renewal, 15th
Symposium of British Ecological Society, July 1973, ed. M.J.

Chadwick and G.T. Goodman, 197-206, (Ref 6).
Accession Number - (CANMET) MMG21740
Accession Date - 810212
Keywords - cat 08, 1973, united kingdom, united states, ecology,
symposia, coal, coal mines + mining, dumps, drainage, waste
disposal, vegetative stabilization, evaluations,
experimentation, ph, sulphur, bibliographies.
Abstract - Investigations were done to determine the alkalinity,
pH and nature and distribution of acid producing pyrite in the
coals and associated strata of the Allegheny Group of the
bituminous coal field of Pennsylvania. Framboidal pyrite
produces abundant acidity, and a point counting method is
presented whereby quantitative estimates of acidity can be
obtained for use in pre-vegetative treatments of coal refuse
banks.

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RANK = 78 - QL SYSTEMS LIMITED - D= 16695 MNT

Publication Date - 680900
Author(S) - Mihok EA and et al
Title - Mine Water Research; The Limestone Neutralization Process.
Citation - US Bur Mines Rep Invest 7191, Sept. 1968, 20p. (ref 6).
Accession Number - (CANMET) MMG3109
Accession Date - 801022
Keywords - 1968, neutralization, quality control, drainage, oxidation, testing, settling, economics, water treatment, cat 08.
Abstract - A pilot plant for treating mine drainage by neutralization with limestone was designed, fabricated, and operated by the Bureau of Mines. The process consists of (1) producing a very fine (minus 400-mesh) limestone slurry, (2) mixing the slurry with the mine water, (3) aerating the resulting mixture to remove carbon dioxide and precipitate iron, and (4) separating the solids from the liquid by sedimentation.

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RANK = 79 - QL SYSTEMS LIMITED - D= 15154 MNT

Publication Date - 681200
Author(S) - Mihok EA and Deul M
Title - Limestone Neutralization - A Low Cost and Effective Treatment for Acid Mine Waters.
Citation - Coal Age, Vol. 73, No. 12, Dec. 1968, pp 65-70, (ref 6).
Accession Number - (CANMET) MMG4561
Accession Date - 800801
Keywords - 1968, neutralization, acids, equipment, field investigations, grinding, chemical analysis, oxidation, settling, compacting, costs, data, cat 08.
Abstract - A method was devised to use wet autogenous grinding of coarse limestone to generate a slurry of limestone fines to treat any desired quantity of acid mine water. The process as finally developed consists of (1) producing a very fine (minus 400-mesh) limestone slurry; (2) mixing the slurry with mine water; (3) aerating the resulting mixture to remove carbon dioxide and precipitate iron; and (4) separating the solids from the liquid by sedimentation. The limestone process has inherent advantages over the conventional lime process; namely, lower cost, widely available raw material, simplicity in design and operation, and much smaller volume of precipitated solids.

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RANK = 80 - QL SYSTEMS LIMITED - D= 13288 MST

Publication Date - 711200
Author(S) - Batarov VD and etal
Title - The Advisability of Mining the Yuzhno-Belozerski Deposit by Cut-And-Fill Methods.
Citation - Can Dep Energy Mines Resour, Mines Branch, Admin., Div. Report Info 71/7, Dec. 1971, 9p. (Translated from Gorn Zh No. 8, 1968).
Accession Number - (CANMET) MNG6840
Accession Date - 800521
Keywords - 1971, canada, translations, russian language pubs, 1968, cut + fill mining, iron ore mines + mining, mine geology, water, drainage, dewatering, caving mining, backfilling, costs, cat C2.
Abstract - The subject of the paper is a choice between a caving mining method and a cut and fill method in an iron ore mine in the Yuzno-Belozerski ore bed in the Soviet Union where there are problems of water inrushes. Some of the related topics discussed are: mine geology, natural sealing by clay beds, the conditions governing the size of the inflows, three alternative methods of caving mining differing by losses and ore dilution. It is indicated that the most efficient method of mining this ore deposit is a room and pillar method with long hole blasting and backfilling with a hardening fill. The advantages of this method over a caving method profit wise are pointed out.

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RANK = 81 - QL SYSTEMS LIMITED - D= 12883 MST

Publication Date - 711100
Author(S) - Olivier R
Title - Peatcrete.
Citation - Eng J, Nov. 1971, pp 25-27, (Ref. 6).
Accession Number - (CANMET) MNG6803
Accession Date - 800505
Keywords - 1971, peat, physical properties, extraction, quebec province, universities, oil, water pollution, filtration, construction, cements, bibliographies, canada, cat 08, cat 10.
Abstract - The nature of peat moss is described, and the peat moss industry in Quebec is outlined. The research at the University of Sherbrooke to develop this material covers three areas: (1) the absorbent properties of peat moss particularly as a means of removing oil from polluted water; (2) as a filter for the removal of dyes and iron from waste water; and (3) as a construction material: (a) the optimal properties of the peat moss cement mix, and (b) laboratory fabrication processes for panels.

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RANK =     82              - CL SYSTEMS LIMITED -        D=  12646  MNT

Publication Date - 790000
Author(S) - Klohn EJ
Title - Taconite Tailings Disposal Practices.
Citation - Current Geotechnical Practice in Mine Waste Disposal,
Committee on Embankment Dams and Slopes of Geotechnical
Engineering Div., American Society of Civil Engineers, New York,
1979, 202-41, (Ref 17).
Accession Number - (CANMET) MNG20634
Accession Date - 800428
Keywords - cat 08, 1979, united states, waste disposal, iron ore
mines + mining, design, construction, tailings, dikes + dams,
tailings ponds, solids pipelining, water, bibliographies, water
pollution.
Abstract - An assessment is made of current engineering practice
for the design and construction of conventional tailings dams
and with this as background the development of tailings disposal
practices in the Minnesota taconite industry are examined. A
summary of the Reserve Mining Cos protracted taconite tailings
controversy is presented with a detailed description of their
new tailings disposal facility- direct dumping into Lake
Superior was planned, 10 years of court battles ensued, and a
tailings pond was used instead.

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RANK =     83              - CL SYSTEMS LIMITED -        D=  12111  MNT

Publication Date - 720000
Author(S) - Kikuchi T
Title - Milling Practice at Furutobe Mine.
Citation - Print No.T-III-e-3, Joint Meeting Min Metall Inst Jpn
- Am Inst Min, Metall & Petrol Eng, Tokyo, 1972, 12 p.
Accession Number - (CANMET) MNG7682
Accession Date - 800319
Keywords - mills, milling, minerals, crushing, washing,
grinding, flotation, concentrating, waste disposal, data, water
pollution, control, tailings, japan, symposia, 1972, cat 10.
Abstract - The plant went into production in May/63 with a
designed capacity of 400 tpd and is currently  processing 650
metric tons of black ore per day after  a 50% expansion in 1969.
Detailed are the mineralogy  (black ore, yellow ore, siliceous
ore); crushing &  washing; grinding; flotation(copper-lead, zinc
pyrite, zinc extraction from copper-lead separation tailings);
metallurgy(copper-lead bulk flotation and separation,  zinc
pyrite flotation and zn extraction, slime  flotation);
concentrate handling and tailings  disposal; and waste water
treatment.

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RANK = 84 - QL SYSTEMS LIMITED - D= 11194 HRT

Publication Date - 791000
Author(S) - Maury V
Title - Spontaneous Subsidence- the Synthesis of Observations and the Possibility of an Initiating Mechanism of Hydraulic Pressure.
Citation - Ind Miner (S Etienne Fr), Oct. 1979, 511-.
Accession Number - (CANMET) MNG20197
Accession Date - 800108
Keywords - cat 03, 1979, france, french language pubs, underground mines + mining, rockfalls, collapse, pore pressures, cracks, ground water, roof control + ground support, drainage, extraction, failure, slabbing, room + pillar mining, monitoring.
Abstract - Based on observations in iron ore, copper, gypsum, and various salt mines in France an account is given of slabbing and roof falls which arise due to a mechanism of interstitial pressures. When the extension of the workings is sufficient displacements induced in the roof open cracks in the strata which then fill with water from overlying reservoirs, and the resulting interstitial pressures lead to slabbing and roof break up. The remedy lies in changing the working heights or by reducing the interstitial pressures by drainage or by caved zones. The usefulness of convergence control, and piezometric and seismic readings are stressed. Original in French with English abstract.

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RANK = 85 - QL SYSTEMS LIMITED - D= 10454 HRT

Publication Date - 780500
Author(S) - Guerra F
Title - Controlling the Phreatic Surface.
Citation - Tailing Disposal Today, 2nd. International Tailing Symposium, Denver, Col., v.2, May 1978, ed. G.O. Argall, paper 15, 292-326, (Ref 16).
Accession Number - (CANMET) MNG19850
Accession Date - 791009
Keywords - cat 08, 1978, united states, quebec province, symposia, tailings, waste disposal, case histories, dikes + dams, seepage, control, stability, safety factors, tailings, drainage, permeability, excavation, bibliographies.
Abstract - A successful case history is described in detail of seepage control in the case of steady state laminar flow in a tailings dam of the Iron Ore Co. of Canada. Aspects discussed in depth include the site, the field and laboratory work performed largely permeability determinations, the embankment dam and tailings disposal, and the steps taken to lower and control the phreatic surface from within the body of the dam to its granular foundation by means of drainage ditches.

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BANK =      86                 - CL SYSTEMS LIMITED -          D= 10826  HMT

Publication Date - 780500
Author(S) - Guerra F
Title - Controlling the Phreatic Surface.
Citation - Tailing Disposal Today, 2nd. International Tailing
Symposium, Denver, Col., v.2, May 1978, ed. G.O. Argall, paper
15, 292-326, (Ref 16).
Accession Number - (CANMET) MMG19850
Accession Date - 791001
Keywords - cat 08, 1978, united states, quebec province,
symposia, tailings, waste disposal, case histories, dikes
+ dams, seepage, control, stability, safety factors, tailings,
drainage, permeability, excavation, bibliographies.
Abstract - A successful case history is described in detail of
seepage control in the case of steady state laminar flow in a
tailings dam of the Iron Ore Co. of Canada. Aspects discussed in
depth include the site, the field and laboratory work performed
largely permeability determinations, the embankment dam and
tailings disposal, and the steps taken to lower and control the

 phreatic surface from within the body of the dam to its granular
 foundation by means of drainage ditches.


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BANK =      87                 - CL SYSTEMS LIMITED -          D= 10779  HMT

Publication Date - 780500
Author(S) - Kloha EJ and Dingeman D
Title - Tailings Disposal System for Reserve Mining Co.
Citation - Tailing Disposal Today, v.2, 2nd. International
Tailing Symposium, Denver, Col., May 1978, ed. G.O. Argall,
paper 9, 178-209.
Accession Number - (CANMET) MMG19803
Accession Date - 790920
Keywords - cat 08, 1978, united states, symposia, tailings,
waste disposal, iron ore mines + mining, tailings ponds,
environment, water, solids pipelining, legislation +
regulations, pollution, physical properties, dust control,
fibrous dust, design.
Abstract - An account is given of the long, protracted court
actions in Minnesota between Reserve Mining Co. and various
federal and state environmental agencies for 8 years that
required the company to cease disposal of iron ore tailings into
Lake Superior and to dispose of them in an especially designed
and monitored series of tailings ponds. A review is made of the
design requirements and the designs finally adopted for the
ponds. Especially stressed are the design arrangements for
control of fibrous dust by disposing of the tailings underwater
instead of spigotting tailings off the dams onto beaches.


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RANK = 88 - QL SYSTEMS LIMITED - D= 10656 MNT

Publication Date - 720000
Author(S) - Lewis AE, Braun RL and Higgins GH
Title - Nuclear Chemical Mining of Primary Sulfide Ores.
Citation - Joint Meeting MMIJ-AIME, Tokyo, 1972, Print No. TIV a 1, 8 p.
Accession Number - (CANMET) MNG8227
Accession Date - 790907
Keywords - 1972, japan, symposia, mines + mining, excavation, solution mining, leaching, in situ, oxidation, minerals, chemicals, shock waves, radiation, data, pollution, economics, analysis, temperature, grade control (ore), mine production, bibliographies, united states, cat 02, cat 10, nuclear explosives.

Abstract - A process for the in situ chemical mining of chalcopyrite ores is described which uses oxygen dissolved in water at high hydrostatic pressure to oxidize chalcopyrite in an ore body broken in place by a nuclear explosion. The method is technically feasible & economically promising. Large increases in reserves of low cost copper and nickel will be obtained if the project is successful. Problems of ground shock and radioactivity are manageable, and environmental problems such as air pollution, open pits, waste dumps, and tailings ponds are eliminated.

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RANK = 89 - QL SYSTEMS LIMITED - D= 10297 MNT

Publication Date - 790300
Author(S) - Nicholls PJ
Title - The Supporting Equipment for Fullface and Other Rapid Tunnelling Systems.
Citation - Min Engr, March 1979, 667-71.
Accession Number - (CANMET) MNG19417
Accession Date - 790626
Keywords - cat 09, cat 03, 1979, united kingdom, full face tunnelling, visits, tunnelling machines, coal mines + mining, underground mines + mining, roof control + ground support, arch supports + trusses, water supply, blasting, waste disposal, mechanization, rate (time), liners + lining, belt conveyors, mine cars, haulage.
Abstract - Experiences are reported on the basis of a visit to coal mining and civil engineering schemes involving tunnelling machines including a water supply scheme and a metro in the U.K. All 5 tunnels except 1 (drill and blast) were bored by machine with a variety of tunnel supports being used including circular arches, roof bolts with wire mesh, and a cast iron circular liner with mine cars used for waste disposal in the civil engineering cases and conveyors in the mining cases.

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BANK =      90                 -  QL SYSTEMS LIMITED  -         D=   9838  MNT

Publication Date - 760200
Author(S) - Okuhara D
Title - Effect of Surface Treatment of Tailings Areas on
Quantity and Quality of Seepage.
Citation - Rio Algom Ltd, Elliot Lake, Feb. 1976, Microfiche
Omg5-0067, 15p.
Accession Number - (CANMET) MNG18958

Accession Date - 790329
Keywords - cat 08, 1976, ontario, field experimentation,
tailings, tailings ponds, water pollution, acids, drainage,
seepage, control, oxidation, air, uranium mines + mining,
leaching, vegetative stabilization, protection, gravels, fines.
Abstract - Test plots on uranium tailings in the Elliot Lake
area were established to test the effects of various means of
surface cover in controlling acid production and subsequent
water pollution drainage. The aim was to prevent air oxidation
by the use of vegetative covers, bark fines and or sawdust,
pyrite free, pit run gravel, and flooded tailings.

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BANK =      91                 -  QL SYSTEMS LIMITED  -         D=   9106  MNT

Publication Date - 760800
Author(S) - Abbott D
Title - Bibliography of Mine Waste Revegetation in Canada.
Citation - Research and Productivity Council of New Brunswick,
Aug 1976, Microfiche M-77-70, 82p., Report no. M77-133.
Accession Number - (CANMET) MNG18218
Accession Date - 780728
Keywords - cat 08, 1976, canada, bibliographies, land
reclamation, tailings, vegetative stabilization, costs, quarries
+ quarrying, monitoring, oil sands, tailings ponds, fly ash,
acids, photography, dumps, coal, mines + mining, symposia.
Abstract - The bibliography compiled for Canmet covers 55 pages
of papers on revegetation of mine wastes by author and covering
Canada and U.S., extensive subject index, papers selected as
important for Canadian conditions under asbestos, coal, costs,
general, gold, quarries, remote sensing, slag, sulphide, tar
sand, and uranium, conference papers and books, and conferences
and symposia.

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RANK =      92              - QL SYSTEMS LIMITED  -         D=   8188  MMT

Publication Date - 770000
Author(S) - Hawley JR
Title - The Use, Characteristics and Toxicity of Mine Mill
Reagents in the Province of Ontario.
Citation - Ontario Ministry of the Environment, 1977, 244p, (Ref
61 + others in text).
Accession Number - (CANMET) MNG17284
Accession Date - 771206
Keywords - cat 08, 1977, ontario, utilization, characteristics,

toxicity, mines + mining, mills, milling, chemicals, flotation,
concentrating, beneficiation, water pollution, waste disposal,
flocculants + flocculation, tailings, tailings ponds, lubricants
+ lubrication, explosives, bibliographies.
Abstract - The toxicities of the following kinds of mine and
mill reagents in use in Ontario are coveredbulk chemicals,
sulphide flotation chemicals, frothers, collectors, modifying
agents, use of sulphide flotation chemicals in actual mills,
metal losses in mine-mill circuits, the chemical and biochemical
oxygen demand of some agents, tailings area design, mine-mill
reagent losses, lubricants, and explosives.

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RANK =      93              - QL SYSTEMS LIMITED  -         D=   7788  MMT

Publication Date - 761000
Author(S) - Brewis AAC
Title - The Sicartsa Project.
Citation - Mng Mag., Oct. 1976, 316-30.
Accession Number - (CANMET) MNG16881
Accession Date - 770902
Keywords - cat 10, 1976, mexico, iron ore mines + mining, mine
development, regional geology, open pit mines + mining,
drilling, blasting, loading, drainage, crushing, mixing,
concentrating, solids pipelining, slurries, tailings, waste
disposal.
Abstract - Described are the construction on the Pacific coast
of Mexico of an integrated mining and steelworks complex
particularly the mining and processing - history, regional
geology, mine geology, open pit drilling, blasting, loading,
crushing and blending, concentrating, slurry pipeline from mine
to steelworks, and waste disposal.

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RANK =     94              -  QL SYSTEMS LIMITED  -        D=   7607  MNT

Publication Date - 770500
Author(S) - Garg OP and Devon JW
Title - Practical Application of Recently Improved Pit Slope
Design Procedures at Schefferville.
Citation - 1st. Open Pit Operators Confer., pap. 10, May 1977,
Labrador City, 10p. (Ref 3).
Accession Number - (CANMET) MNG16700
Accession Date - 770803
Keywords - cat 03, 1977, newfoundland + labrador, quebec
province, symposia, iron ore mines + mining, slopes, stability,

design, procedures, angle of repose, optimization, fractures,
ground water, steep dipping mineral deposits, leaching,
permafrost, rocks, drainage, slope stability research, joints,
field investigations, monitoring, shear strength, safety
factors, bibliographies, geophysical surveys.
Abstract - An attempt was made to steepen the open pit angle at
an iron ore mine in Quebec allowing for leached and fractured
rock and ground water. A monitoring program was done which
included- shear strength determination, measuring orientation of
joints, faults and bedding planes, collecting geological info.
from drilling, and determining permafrost distribution and water
table location.

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RANK =     95              -  QL SYSTEMS LIMITED  -        D=   7549  MNT

Publication Date - 770000
Author(S) - Charbonneau D and Morrison D
Title - Mine Dewatering at Knob Lake.
Citation - C.I.M. Directory, 1977, 113-5.
Accession Number - (CANMET) MNG16642
Accession Date - 770725
Keywords - cat 10, 1977, quebec province, iron ore mines
+ mining, open pit mines + mining, dewatering, drainage, water
control, excavation, wells, drilling, pumping.
Abstract - The aims of dewatering an open pit iron ore mine in
northern Quebec include economics, bank stability and efficiency
of operations, and the 2 methods in use include ditches, sumps
and wells. Well site selection, well drilling, developing or
washing the well, pumps and sumps, ditches and dykes.

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RANK = 96 - CL SYSTEMS LIMITED - D= 6702 SNT

Publication Date - 760900
Author(S) - Schabas W
Title - System Sprays Silt into Slurry.
Citation - Can. Min. J., Sept. 1976, 39-43.
Accession Number - (CANMET) MMG15359
Accession Date - 770614
Keywords - cat 05, 1976, ontario, open pit mines + mining, iron ore mines + mining, surface stripping, overburden, materials handling, excavation, slurries, water jet drills and drilling, pumping, solids pipelining, clays, sands, pumps, water, hydraulic mining, hydraulic equipment, transportation, waste disposal.

Abstract - The use of Marconajets for removal of a silty overburden at an open pit iron ore mine in Ontario is described re. the material to be moved, structure of the jets, problems with the silt and pumping.

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RANK = 97 - CL SYSTEMS LIMITED - D= 6087 BNT

Publication Date - 710700
Author(S) - Bubbers BL
Title - Tunnelling on the Brixton Extension of the Victoria Line.
Citation - Tunnels and Tunnelling, July 1971, pp.235-42.
Accession Number - (CANMET) MMG15169
Accession Date - 770105
Keywords - cat 09, 1971, united kingdom, tunnelling, shaft sinking, liners + lining, boreholes, drainage, grouting, monitoring, measurement, ground water, ground control research, underwater tunnelling, freezing.
Abstract - This consists of twin tunnels, 5.5 km. long and of 3.81m. diameter inside lining. The author describes reconnaissance boreholes and shafts and profiling of the bed of the Thames, grades approaching and leaving stations, epoxy resin grout ahead of faces to control water, bolted cast-iron and concrete segment linings, driving of 6.5-meter station and platform tunnels, monitoring and measurement of ground movement, ground freezing for sinking through water-bearing clay.

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RANK = 98 - CL SYSTEMS LIMITED - D= 5876 BNT

Publication Date - 740400
Title - International Engineering Effort in Greenland.
Citation - Engng Dig., April 1974, 29-32.
Accession Number - (CANMET) MMG14957
Accession Date - 761201
Keywords - cat 10, 1974, europe, arctic + subarctic regions, iron ore mines + mining, mine development, underground crushing, conveying, transportation, haulage, concentrating, permafrost, concrete, waste (rock), fills, insulation, trackless mining, water supply, corrosion, ports.
Abstract - An iron ore mine constructed under difficult conditions in Greenland is described covering an adit 600 ft. above the water, underground crushing, an aerial ropeway to the concentrator opposite the ore mountain, construction methods in permafrost, mine production rates, the use of seawater in concentrating, and the port.

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RANK = 99 - QL SYSTEMS LIMITED - D= 5515 MNT

Publication Date - 710100
Title - Horizontal Freezing Technique Used for New York Sewer Tunnel.
Citation - Tunnels and Tunnelling, Jan. 1971, 21-3.
Accession Number - (CANMET) MNG14601
Accession Date - 761005
Keywords - cat 09, cat 03, 1971, tunnels, tunnelling, roof control + ground support, freezing, refrigeration, united states, waste disposal, stabilization, consolidation, explosives, ground water, smoothwall blasting, liners + lining.
Abstract - A distance of 350 ft. of half rock half earth was stabilized by ground freezing as part of a sewer project in New York. The refrigeration method, water resistant explosives, use of a pilot tunnel, smoothwall blasting and iron rings with concrete lining for support are referred to.

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RANK = 100 - QL SYSTEMS LIMITED - D= 5442 MNT

Publication Date - 760800
Author(S) - Cayton S
Title - Marconaflo Strips Silt and Pumps New Life into Caland.
Citation - Engng, Mng J., Aug. 1976, 86-8.
Accession Number - (CANMET) MNG14525
Accession Date - 760920
Keywords - cat 04, 1976, ontario, surface stripping, open pit mines + mining, iron ore mines + mining, materials handling, slurries, pumping, fines, water, solids pipelining, waste disposal, sands, particles, clays, water jet drills and drilling, dredging, overburden, hydraulic mining.
Abstract - An hydraulic slurry mining program is planned to strip redeposited silt from Calands Ore Co. open pit on the Steep Rock Iron Range at Atikokan, Ontario. The Marconaflo units will include a DYNAJET capsule, and a caisson jet.

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RANK = 101 - QL SYSTEMS LIMITED - D= 5279 MNT

Publication Date - 760800
Author(S) - Jackson LDA and Kirk TA
Ti[illegible]he Linatex Solids Recovery System.
[illegible] - C.I.M. Bull., Aug. 1976, 79-85.
[illegible] Number - (CANMET) MNG14362
[illegible] Date - 760830
[illegible] cat 08, 1976, canada, manufacturers, sands, [illegible]ent (equipment), fines, filters, filtration, tailings, [illegible]centrating, water supply, water treatment, conservation, quality control, water, coal, extraction, screens + screening, waste disposal, slurries, clays, minerals, equipment, separation, classification, concrete.
Abstract - The solids recovery system can be used for desliming and dewatering glass and concrete sand, filtering and dewatering iron ore fines, dewatering vermiculite tails, clarifying scrubber effluents, cleaning and dewatering fine coal residues, sizing iron ore autogenous mill discharge, removing organics such as coal from concrete sand, and dewatering china clay. Included are drawings and photos showing parts of the system and specific performance data.

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RANK = 102 - QL SYSTEMS LIMITED - D= 5104 NRT

Publication Date - 760200
Author(S) - Ryan J and Stroehlein JL
Title - How Copper Smelter Byproducts Enhance Plant Growth in Tailing.
Citation - World Min., Feb. 1976, 38-41, (Ref 13).
Accession Number - (CANMET) MRG14187
Accession Date - 760805
Keywords - cat 08, 1976, united states, air pollution, acids, vegetative stabilization, tailings, tailings ponds, copper mines + mining, field experimentation, dumps, evaluations, waste disposal, alkalies, neutralization, ph, soils, bibliographies, waste utilization, extraction.
Abstract - A field experiment was done to determine germination and growth of 5 plant species on the sludge from neutralization of acid mine water, and on both acid and alkaline mine tailings and to examine the effects of sulphuric acid and a jarositic iron sulphur precipitate on growth on the alkaline tailing. Sulphuric acid can be used effectively to enhance the fertility and the alkaline mine tailings and a sludge was identified as a suitable growth medium for plants or as an amendment for either acid or alkaline tailing.

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RANK = 103 - QL SYSTEMS LIMITED - D= 4580 NRT

Publication Date - 750600
Author(S) - Cho E
Title - Stabilization of Waste Water from Sulfide Ore Milling Operations.
Citation - Trans., Soc. Min. Engr., AIME, Vol. 258, June, 1975, 111-114.
Accession Number - (CANMET) MRG13662
Accession Date - 760622
Keywords - 1975, united states, symposia, chemical stabilization, tailings, pollution, cat 08.
Abstract - Dissolved polythionates (sulfur-oxygen compounds) injuriously pollutes streams. They originate in alkaline flotation circuits but will oxidize to acidify streams if not impounded until oxidation and neutralization have been effected. Author gives equations and explains the chemistry of using oxidizers, especially ozone, to oxidize polythionate pollutants rapidly so that impounded tailings can be neutralized or stabilized.

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RANK = 104 - QL SYSTEMS LIMITED - D= 4263 NRT

Publication Date - 730300
Author(S) - Lejcher TR
Title - Utilizing Treated Municipal Wastes for Strip Mine Reclamation.
Citation - SME, March, 1973, pp. 49-50.
Accession Number - (CANMET) MRG13345
Accession Date - 760527
Keywords - 1973, cat 08, land reclamation, legislation + regulations, waste disposal, waste utilization, neutralization.
Abstract - Strip mine run-off is heavily polluted with Fe, Mn, Al etc. Because of pyrite etc. in the spoil another serious problem is the solids to be disposed of after sewage treatment. The author discusses treating acid spoil with alkaline solids from sewage treatment plants to solve two disposal (pollution) problems.

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RANK =    105              - QL SYSTEMS LIMITED -         D=   3129  HNT

Publication Date - 741000
Author(S) - Grim EC and Hill RD

Title - Environmental protection in surface mining of coal.
Citation - Environmental Protection Tech. Series, Oct. 1974,
274p.
Accession Number - (CANMET) MNG12200
Accession Date - 750224
Keywords - 1974, mine environment, protection, cat 08, surface
stripping, coal mines + mining, coal, planning, land
reclamation, mining methods, erosion, control, slides, water
pollution, blasting, vibrations, damages, soils, vegetative
stabilization, construction, roads, costs, acids, drainage,
backfilling, united states, legislation + regulations.
Abstract - Premining planning is stressed and attention is given
to including mined-land reclamation into the mining method
before disturbance. Strip and auger mining as well as equipment
are described and evaluated. New mining methods that will
maximize aesthetics and minimize erosion, landslides,
deterioration of water quality are discussed. Blasting methods
and vibration damage controls are recommended. Methods of land
reclamation including spoil segregation, placement, topsoiling,
grading, burying of toxic materials, and revegetation are noted.
Technology for the control of erosion and sediment in the mining
areas is given. Guidelines for planning, location, construction,
drainage, maintenance, and abandonment of coal-haul roads are
included. Costs are given for different degrees of reclamation
and remedial measures for controlling pollution from surface
mines. Water quality change is discussed with stress on acidity
formed from exposed pyritic material and on increase in
dissolved solids.

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RANK =    106              - QL SYSTEMS LIMITED -         D=   2383  HNT

Publication Date - 740000
Author(S) - Paone J, Morning JL, Giorgetti L and
 US Bureau Mines
Title - Land utilization and reclamation in the mining industry,
1930-71.
Citation - U.S.B.M., Info. Circ. 8642, 1974, 61p.
Accession Number - (CANMET) MNG11462
Accession Date - 741008
Keywords - 1974, mines + mining, land reclamation, united
states, data, statistics, dumps, waste disposal, surface
stripping, cat 08.
Abstract - Data are included on land use for wastes from
underground and surface mining, for wastes from mill operations,
and on subsidence. The 10 leading states in land use for mining
in 1971 were in decreasing order, Kentucky, Pennsylvania,
Arizona, Ohio, California, Florida, West Virginia, Illinois,
Minnesota, and Indiana. Mineral commodities accounting for a
major portion of land use are in decreasing order, bituminous
coal, sand and gravel, stone, copper, phosphate rock, iron ore,

and clay. Reclamation over the 42 year period was largely on
lands used for the surface mining of bituminous coal.

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BANK =    107              - QL SYSTEMS LIMITED -          D=   2107  MNT

Publication Date - 721000
Author(S) - Dean KC and Havens R
Title - Stabilization of problem mineral wastes.
Citation - Soc. Mng Engrs, AIME, Oct. 18-20, 1972, 15p.
Accession Number - (CANMET) MNG11200
Accession Date - 740731
Keywords - 1972, vegetative stabilization, waste disposal,
tailings, milling, costs, mills, cat 08, acids, sulphur, dumps,
tailings ponds, chemical stabilization, agglomerating.
Abstract - A summary is made of effective methods developed for
vegetating average tailings, the cost differential between the
various methods, and procedures that may be applicable for
achieving stabilization of pyrite containing wastes that may
oxidize and become excessively acidic. The use of buried layers
of sewage sludge to prevent this acidification is described.

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BANK =    108              - QL SYSTEMS LIMITED -          D=   383  MNT

Publication Date - 720600
Author(S) - Keyes RR
Title - Discussion of in place leaching at Miami mine, Miami,
Arizona.
Citation - Transactions of the Society of Mining Engineers, vol.
252, June 1972, 186-7, (6 Refs).
Accession Number - (CANMET) MNG9452
Accession Date - 730913
Keywords - 1972, in situ, leaching, oxidation, acids, ph,
chemicals, copper mines + mining, cat 02.
Abstract - Chemical dissolution of chalcocite by acidic ferric
sulphate is well known. Resulting elemental sulphur may be
oxidized to sulphuric acid by heated ferric sulphate. Laboratory
tests confirmed stoichiometric relations of 1 part copper
dissolved in 1.756 parts ferric iron reduced, using CP chemicals
dried ore samples, and apparatus cleaned with portable water.
Recirculation with open drainage percolation to increase copper
in leaching solvent was followed successfully in both laboratory
and pilot tests. (Author).

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RANK = 109 - QL SYSTEMS LIMITED - D= 10793 HNT

Publication Date - 770100
Author(S) - Nilsson D
Title - Open Pit or Underground Mining.
Citation - World of Iron Ore, 38th. Annual Mining Symposium, Minnesota Section of American Institute of Mining Engineers, Jan. 1977, ed. L. Klatt Graven, paper 14, Duluth, Minnesota, 28p.
Accession Number - (CANMET) MNG19817
Accession Date - 790920
Keywords - cat 07, 1977, united states, sweden, symposia, iron ore mines + mining, costs, analysis, overburden, extraction, planning, underground mines + mining, open pit mines + mining, waste (rock).
Abstract - The subject is discussed in the context of various open pit and underground iron ore mines in Sweden and related experience referring to costs for both methods, length of time to continue open pit mining and possible switch to underground extraction, accidents at both, costs for waste rock removal for both, waste rock removal and truck size, cut offs for them, extraction ratios, final slope angle and waste rock removed, and an example study at a Swedish mine to determine ultimate pit depth.

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RANK = 110 - QL SYSTEMS LIMITED - D= 24226 HNT

PUBLICATION DATE: 830500
AUTHOR(S): Dave NK and Lim TP
TITLE: Migration of contaminants from underwater buried tailings- laboratory investigations of Ra-226 transfer flux. (Migration des contaminants a partir de steriles d'uranium enfouis au- dessous des eaux- etude en laboratoire du flux de transfert du Ra- 226).
CITATION: CANADA CENTRE for MINERAL and ENERGY TECHNOLOGY, CANMET, Mining Research Lab., Report MRP/MRL 83-49, 30pp., 18 ref., May 1983.
ACCESSION NUMBER: CANMET MNG26251
ACCESSION DATE: 830826
ABSTRACT: Lab. lysimeter tests were used to study the migration of contaminants from underwater buried pyritic uranium tailings to the overlaying water column. The tests were conducted under 2 conditions: a continuous flow steady state condition and a no- flow stagnant water column condition. The parameters measured were the mass transfer flux 'J', the transfer coefficient 'K', and the tailings porewater concentration 'C' profile as a function of depth and their variations with time for Ra-226 and total dissolved solids.
KEYWORDS: cat 08, 1983, ontario, uranium mines + mining, tailings, water pollution, radioactive isotopes, tailings ponds, water, laboratory experimentation, seepage, dispersants + dispersion, bibliographies, parameters.

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RANK = 111 - QL SYSTEMS LIMITED - D= 15834 MNT

Author(S) - Nichols I

Title - Field Techniques for the Economic and Geotechnical Evaluation of Mining Property for Opencast Mine Design, Knob Lake, Quebec.

Citation - Quarterly Journal of Engineering Geology (London), Vol. 1, No. 3, Dec. 1968, pp 169-180, (ref 7).

Accession Number - (CANMET) MNG4007

Accession Date - 800924

Keywords - ground water, dewatering, open pit mines + mining, iron ore mines + mining, quebec province, control, water, design, drawdown, flow, permeability, water tables, wells, measurement, pore pressures, shear strength, field investigations, cat 10.

Abstract - The experience of the 1st 12yrs of min. operations at Knob Lake has shown that severe ground-water problems exist in the min. area. These conditions are a result of a high water table, active recharge rates and high permeability values of the geol. formations, which in turn have enhanced the instability of artificial slopes. In order to account for these factors in obtaining optimum mine-design criteria, a detailed geotech. programme, combining hydrolog., geohydrolog., geochem. and soil mechanics invest. with the standard development programme of econ. property evaluation, is proving to be an efficient framework within which to conduct these invest. More specifically, the hydrolog. programme is focused on water-balance studies for selected ground-water basins, while the geohydrology studies encompass water-table and pore-pressure measurements and the construction of flow nets for both ground-water basins and local areas (ore zones). The geochem. programme, now in its initial stages, is being invoked to define ground-water flow by utilizing certain minor and trace elements as natural ground-cover.

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RANK = 112 - QL SYSTEMS LIMITED - D= 15173 MNT

Publication Date - 690000

Author(S) - Cochran W

Title - Grace Mine Iron Ore Waste Disposal System and Estimated Costs.

Citation - US Bur Mines Inf Circ 8435, 1969, 17 p. (references).

Accession Number - (CANMET) MNG4584

Accession Date - 800801

Keywords - 1969, waste disposal, costs, tailings, variables, evaluations, iron ore mines + mining, economics, procedures, cat 08.

Abstract - The mineral waste disposal system at the Grace mine, Morgantown, Pa., was designed to minimize environmental effects while allowing much of the waste from the Fe mine, mill, and concentrator to be utilized. Standard cost estimating procedures were used by the Bur. Mines to determine waste disposal costs.

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RANK = 113 - QL SYSTEMS LIMITED - D= 13047 MNT

Publication Date - 711100
Author(S) - Gibbs HP
Title - Methods for the Removal of Sulphur Dioxide from Waste Gases.
Citation - Canada Dept of Energy, Mines & Resources, Mines Branch, Mineral Sciences Div, Inf Circ. IC 272, Nov. 1971, 174 p. (Ref. 451).
Accession Number - (CANMET) MMG6732
Accession Date - 800507
Keywords - 1971, toxic gases, waste disposal, extraction, control, air pollution, combustion, fuels, oxidation, bibliographies, chemicals, sulphur, canada, cat 06.
Abstract - Methods for the removal of sulphur dioxide from waste gases from the smelting of sulphide ores or the combustion of sulphur containing fuels are reviewed. These include scrubbing with aqueous solutions or slurries and with ammoniacal solutions, additive injection methods, adsorption on active carbon and on metal oxides, catalytic oxidation methods, molten salt processes, reduction to elemental sulphur, applications of organic reagents, and physical separation methods. The chemistry and current stage of these processes are given.

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RANK = 114 - QL SYSTEMS LIMITED - D= 12233 MNT

Publication Date - 710600
Author(S) - Hill RD and Wilmoth RC
Title - Limestone Treatment of Acid Mine Drainage.
Citation - Trans Soc Min Eng Am Inst Mech Eng,Vol. 250, June 1971, pp 162-166, (Ref. 23).
Accession Number - (CANMET) MMG7131
Accession Date - 800324
Keywords - 1971, sedimentary rocks, acids, drainage, neutralization, critiques and reviews, bibliographies, chemicals, cat 08.
Abstract - A limestone with a high CaCO3 content and with low magnesium and other impurities is best suited for treating acid mine drainage. The choice of a limestone should be based on the chemical composition, cost, and a laboratory test between the actual limestone and acid mine drainage. For pulverized limestone systems the smaller the limestone particle size the faster the reaction & the greater the use of the limestone. An excess of 1.4-3 times the stoichiometric amount of limestone is required. Expanded beds, tumblers, and pulverized limestone systems are applicable to ferric iron acid mine drainage. Above a ferrous iron concentration of 50-100 mg/l. limestone treatment is not applicable. Below this range tumblers and pulverized systems of aeration are feasible. A limestone-lime system may be applicable in some situations.

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RANK = 115 - QL SYSTEMS LIMITED - D= 11857 MNT

Publication Date - 791100

Author(S) - Skoglund TW and Hanson HW

Title - Water Balance and Tailing Deposition Aspects of Closed System Tailing Basins.

Citation - Min Congr J., Nov. 1979, 27-31, (Ref 9).

Accession Number - (CANMET) MNG20484

Accession Date - 800304

Keywords - cat 08, 1979, united states, tailings ponds, tailings, water supply, operation (equipment), control, management, iron ore mines + mining, construction, bibliographies.

Abstract - Operation of closed system tailings ponds involves water levels and tailings deposition characteristics. The common factors in these systems are no regular surface outflows and recycling of excess basin water to the plant. The discussion is related to iron ore mining in Minnesota.

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RANK = 116 - QL SYSTEMS LIMITED - D= 9581 MNT

Publication Date - 610500

Author(S) - Hanes F

Title - Assessment of Waste Rock from the Hilton Mine for Suitability as Railroad Ballast.

Citation - Mines Branch, Miner. Process. Div., test rep., MPT 61-55, May 1961, 8p.

Accession Number - (CANMET) MNG18699

Accession Date - 781215

Keywords - cat 08, cat 05, 1961, canada, confid, waste (rock), iron ore mines + mining, waste utilization, railroads, construction, testing, aggregates, petrology, density, absorption + adsorption, abrasion, rocks.

Abstract - A petrographic study was made of a sample of waste rock from the Hilton mine for suitability as railroad ballast and physical acceptance tests were made on coarse aggregates (density, absorption, and abrasion), and results compared to a standard.

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RANK = 117 - QL SYSTEMS LIMITED - D= 7944 MNT

Publication Date - 770700

Title - How Mine Water is Clarified at Silverdale Colliery.

Citation - Mine and Quarry, July Aug. 1977, 6-8.

Accession Number - (CANMET) MNG17038

Accession Date - 770927

Keywords - cat 08, 1977, united kingdom, coal mines + mining, water, costs, equipment, automation, minerals, water pollution, neutralization, ph, acids, oxidation, air, control, control systems.

Abstract - A continuously operated water treatment plant for a coal mine is described that has automatic control and which neutralizes acid iron water and aerates it for a coal mine in the U.K.

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RANK =     118              - QL SYSTEMS LIMITED -          D=   6311  MNT

Publication Date - 770400
Author(S) - Maury V
Title - Conversion of a Disused Mine to Oil Storage.
Citation - C.I.M. Meet., Ottawa, April 1977, no. 115, 20p.
Accession Number - (CANMET) MMG16123
Accession Date - 770518
Keywords - 1977, ontario, symposia, underground mines + mining,
france, oil, storage, voids, utilization, iron ore mines
+ mining, room + pillar mining, stresses, pillars, rock
mechanics, stability, seepage, ground water, liners + lining,
pumps, pumping, water treatment, monitoring, pore pressures,
noise, water tables, costs, geophysical surveys.
Abstract - A geotechnical investigation was done to determine
stability mechanisms in an abandoned room and pillar iron mine,
natural rock stresses, stability of certain zones, and seepage
patterns of ground water which prevent oil leakage. A pumping
system allows for oil withdrawn, and there is a water treatment
plant and a monitoring system for the cavities consisting of
pore pressure instruments, geophones, recorders for ground noise
and piezometers.

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RANK =     119              - QL SYSTEMS LIMITED -          D=   6210  MNT

Publication Date - 770200
Author(S) - Irvine JC
Title - Pillar Recovery at the Pea Ridge Mine.
Citation - A.I.M.E., Ann. Meet. Las Vegas, Feb. 1977, 20p.
Accession Number - (CANMET) MMG16021
Accession Date - 770504
Keywords - cat 02, 1977, united states, symposia, pillar
recovery, underground mines + mining, water gel explosives,
sealing, blastholes, caving mining, draw point loading,
preprints, loaders, downhole drills + drilling, noise control,
damages, air pollution, mine gases, vibrations, blasting,
compressed air, pressures, barriers + shields, water.
Abstract - A pillar recovery progres at an iron ore mine is
described in this preprint re. containing of water gel
explosives in blastholes, drawpoint and sublevel caving,
downhole drilling, loss of drill pipe, noise control for drills,
water gel blasting, control of damages due to blasting shock,
air blast damage control with water barriers, and loading with
loadhaul-dumpers.

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RANK =     120             -  QL SYSTEMS LIMITED  -         D=   4162  RRT

Publication Date - 750900
Author(S) - Cohen A and Geller L
Title - A Cooling Water Intake Tunnel under Lake Erie.
Citation - Canmet, Sept. 1975, D.S. 75-9, 1-17, (Ref 3).

Accession Number - (CANMET) NMG13244
Accession Date - 760427
Keywords - 1975, ontario, tunnels, underwater tunnelling, ground
water, toxic gases, hazards, geology, bibliographies, cooling,
electric power generation.
Abstract - An 1800 ft cooling water tunnel for intake to a
thermal generating station in Ontario was constructed which was
21 ft in diameter, horseshoe shaped, horizontal and driven
through bedded, shaley limestones. Water bearing seams
containing hydrogen sulphide gas were met. Described are the
geological investigations, influence of results on the final
design, measures in the contract, and methods used to
continually assess actual conditions.

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RANK =     121             -  QL SYSTEMS LIMITED  -         D=   3272  RRT

Publication Date - 730800
Author(S) - Bartlett John
Title - Soft-ground tunnelling system proved practicable.
Citation - S.A. Mng. Engng. Journal, Aug. 1973, pp.15,23,26.
Accession Number - (CANMET) NMG12344
Accession Date - 750506
Keywords - excavation, gravels, pumping, slurries, separation,
tunnelling, tunnelling machines, sealing, ground water,
grouting, 1973, cat 09.
Abstract - Describes Bentonite Shield tunnelling system for
rapid economical advances of near-surface tunnels through water-
bearing gravel and sand. Bentonite slurry is pumped into
sealed drilling chamber to penetrate and to consolidate 0.5m of
exposed gravel and sand and to push back water at pressure of
2kg/cm2. The slurry suspends spoil, except large cobbles, from
the cutter for pumping to surface, separation and disposal.
Prototype advances about 0.5m per hour. Except to excavate,
build and grout three 4.1 x 0.5m rings through water-bearing
gravel in less than two hours. Machine jacks itself forward
against completed rings (cast iron segments).

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RANK = 122 - GL SYSTEMS LIMITED - D= 3003 MNT

Publication Date - 720700
Author(S) - Matsuguma K, Kunitani I, Koga Y, Teshima T and Tanaka H
Title - About efficient quantity of water in water spray blasting.
Citation - Mag Safety, July 1972, 10.
Accession Number - (CANMET) MNG12074
Accession Date - 750203
Keywords - 1972, safety, efficiency, water, sprayers, blasting, coal mines + mining, mine fires, control, japanese language pubs, propagation, explosions.
Abstract - In coal blasting the danger of flame propagation can be suppressed by water spraying on the free face. A test was done in an iron pipe gallery about 1 meter in diameter. The efficient quantity of water in the neighborhood of the excitative source was 8.8-17.2 c.c. per cum. and the radius of water drop was 0.017 cm.

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RANK = 123 - GL SYSTEMS LIMITED - D= 2392 MNT

Publication Date - 740300
Author(S) - Faber JH, Eckard WE, Spencer JD and US Bureau Mines
Title - Ash utilization.
Citation - 3rd. inter. ash utilization symp. Pittsburgh, March 1973, 317p, (refs after articles or in footnotes).
Accession Number - (CANMET) MNG11471
Accession Date - 741009
Keywords - 1974, fly ash, waste utilization, cat 03, symposia, united states, europe, coal, cements, pumping, australia, united kingdom, waste disposal, dikes + dams, construction, roads, extraction, minerals, india, land reclamation, soils, dumps, absorption + adsorption.
Abstract - The topics of the symposium were the following - production and utilization of fly ash in the U.S., activities of the economic commission for Europe in the field of ash utilization, review of current research on coal ash in the U.S., cenospheres, multiple byproduct utilization, the uses of fly ash in ferrocement mix design, specifications and methods of using fly ash in portland cement concrete, portland pozzolan cement, bureau of reclamation experiences with fly ash and other pozzolans in concrete, a practical approach to producing pumpable concrete, fly ash production and utilization in Australia, factors affecting pozzolan marketing, properties of powerplant waste sludges, large tonnage uses of pfa in England and other European countries, bottom ash and boiler slag, ash disposal in dams, mounds, structural fills, and retaining walls, utilization of ash in stabilized base construction, use of waste sulphate on transpo 72 parking lot, marketing powerplant aggregates as a road base material, iron and alumina extraction from powerplant fly ash in Poland, studies on Indian fly ashes and their use in structural concrete, land reclamation, and environmental benefits of ash utilization, soil making potential of powerplant fly ash in mined land reclamation, basic soil benefits from ash use, lets get rid of the dump, and an evaluation of the adsorptive properties of fly ash with reference to a pulp and paper mill waste effluent.

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RANK = 124 - QL SYSTEMS LIMITED - D= 1394 MMT

Publication Date - 730400
Author(S) - Pregermain S and Mines Branch EMR
Title - Examination of the oxygenated water test for characterizing the aptitude of coals to spontaneous combustion.
Citation - Mines Branch, M.R.C., Int. Rep. 73-59, April 1973, 19p.
Accession Number - (CANMET) MNG10472
Accession Date - 740313
Keywords - 1973, water, testing, evaluations, cat 06, coal, spontaneous combustion, translations, temperature, french language pubs, air, oxidation, analysis.
Abstract - The principle of the test is based on the establishment and examination of the curve representing the variation in temperature in relation to the time a sample is subjected to the action of oxygenated water under adiabatic conditions. The use of an apt modus operandi permits the water test to be quantitative and shows that the value of the index obtained depends on the pyritic content of the coal.

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RANK = 125 - QL SYSTEMS LIMITED - D= 1277 MMT

Publication Date - 611200
Author(S) - Lapointe CM and Mines Branch EMR
Title - Tracer study of underground water flow at Steep Rock Iron Mines, Ltd.
Citation - Mines Branch, Invest. Rep., I.R. 61-140, Dec. 1961, 26p, (11 Refs).
Accession Number - (CANMET) MNG10354
Accession Date - 740222
Keywords - 1961, confid, radioactive isotopes, cat 10, underground mines + mining, water, flow, radiation, monitoring, detectors, detection, seepage, measurement, bibliographies, dumps, tailings ponds.
Abstract - Tritiated water was used as a radioactive tracer to investigate the source and the rate of seepage in the underground workings of the mines. Tests were done to relate water from a pool near a surface dump to the 700 and 900 ft. levels in the mine. The tritium measurements were made by the liquid scintillation method.

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RANK = 126 - CL SYSTEMS LIMITED - D= 1037 MNT

Publication Date - 730000
Author(S) - Sullivan PM, Stanczyk MH, Spendlove MJ and
US Bureau Mines
Title - Resource recovery from raw urban refuse.
Citation - U.S.B.M., Rep. Invest. 7760, 1973, 28p,(22 Refs).
Accession Number - (CANMET) MNG10113
Accession Date - 740201
Keywords - 1973, waste utilization, waste disposal, materials, extraction, concentrating, bibliographies, screens + screening, gravity, separation.
Abstract - The Bureau installed and operated a 5 tph pilot plant for continuous mechanical separation of values contained in raw urban refuse. The process relies on multistage processing including shredding, air classification, screening, gravity concentration, and electrostatic separation. Compactor trucks deliver raw refuse to the pilot plant. The loads are separated into concentrates of light gage iron, massive metals, glass, putrescibles and waste combustibles, paper and plastics.

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RANK = 127 - CL SYSTEMS LIMITED - D= 24606 MNT

PUBLICATION DATE:	830315
AUTHOR(S):	Chapman JP, Ricks BL and Thompson TL
TITLE:	The La Perla-Hercules iron concentrate pipeline: innovations in design. (Le pipeline de fer concentre de la compagnie Perla- Hercules: la conception et les nouveautes).
CITATION:	Proceedings of the 8th International Technical Conference on Slurry Transportation, March 15-18, 1983, San Francisco, Cal., p.441, 12pp., 2 ref., March 1983.
ACCESSION NUMBER:	CANMET MNG26630
ACCESSION DATE:	831110
ABSTRACT:	The 382 km long pipeline is in a Mexican desert and serves 2 mines. Some 1.5 million tons of concentrate will be pumped a distance of 86.7 km in an 8 in. pipe to Hercules where 3.0 million tons will be added to the passing flow. It is the 1st long distance slurry pipeline to have more than 1 source of feed and the blended flow travels another 295 km in a 14 in. diameter pipeline. Other innovations featured by the slurry pipeline are: a programmable controller based supervisory control system, a new slurry check valve, a unique water conservation scheme, diesel drives and a concentrate blending system.
KEYWORDS:	cat 05, 1983, mexico, solids pipelining, iron ore mines + mining, design, bibliographies, control systems, valves, conservation, water, mining.

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BANK =     128              - CL SYSTEMS LIMITED -          D=  24585  MNT

PUBLICATION DATE:   830915
AUTHOR(S):          Klinkhammer G, Elderfield H and Hudson A
TITLE:              Rare earth elements in seawater near
                    hydrothermal vents.  (Les  elements des
                    terres rares dans l'ocean pres des events
                    hydtothermals).
CITATION:           Nature, v.305, n.5931, p.185, 4pp., 22 ref.,
                    Sept. 15, 1983.
ACCESSION NUMBER:   CANMET MNG26609
ACCESSION DATE:     831107
ABSTRACT:           Rare earth element patterns in the deep
                    Pacific are strongly  depleted in the lighter
                    elements and have a large negative cerium
                    anomaly.  These patterns and associated
                    concentration-depth  profiles are maintained
                    by regeneration in deep waters modified  by
                    preferential scavenging of the lighter
                    elements.  Scavenging  by iron and manganese
                    rich hyrothermal plumes might explain why
                    vast areas of sediments far removed from
                    spreading centres  contain a metalliferous
                    component.  (Au).
KEYWORDS:           cat 10, 1983, south pacific, minerals, marine
                    mining, field  investigations,
                    bitliographies.

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BANK =     129              - CL SYSTEMS LIMITED -          D=  24532  MNT

PUBLICATION DATE:   830331
AUTHOR(S):          Simon-Carves of Canada Ltd.
TITLE:              A study of facilities relative to
                    stabilization of uranium mill  tailings at
                    Elliot Lake.  (Une etude des accommodations
                    relative  a la stabilisation des residus

                    d'uranium provenant du  concentrateur du Lac
                    Elliot en Ontario).
CITATION:           Canada Centre for Mineral and Energy
                    Technology, Canmet,  contract OSQ82-00241,
                    67pp., March 31, 1983.
ACCESSION NUMBER:   CANMET MNG26556
ACCESSION DATE:     831018
ABSTRACT:           Facilities to stabilize uranium mill tailings
                    at Elliot lake  will include pyrite
                    flotation, roasting, acid and phosphate
                    production, site preparation, utilities and
                    project overhead.   Two examined alternatives
                    were: (1) production of 596,000 short  tons
                    acid/year and the sale of 246,000 short tons
                    which are in  excess of the Elliot Lake
                    mill's requirements; and (2) production  of
                    only 350,000 short tons/year of acid which
                    would entail  disposal of the excess pyrite
                    floated from the Rio Algom mills.   Capital
                    costs of these schemes are cited.
KEYWORDS:           cat 08, 1983, ontario, stabilization, uranium
                    mines + mining,  tailings, management,
                    capital costs, waste utilization, acids.

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RANK =     130              -  QL SYSTEMS LIMITED  -          D=  24391  MNT

PUBLICATION DATE:   830800
AUTHOR(S):          Watkin EM and Watkin J
TITLE:              Keep reclamation costs low with effective
                    revegetation.   (Maintenons les couts de
                    rehabilitation peu eleves avec une
                    revegetation efficace).
CITATION:           Can Min J, v.104, n.8, p.33, 3pp., Aug. 1983.
ACCESSION NUMBER:   CANMET MBG26416
ACCESSION DATE:     830923
ABSTRACT:           A number of Canadian mining companies have
                    carried out  investigations into the
                    revegetation of tailings containing iron
                    sulphides.  Both Inco and Noranda-Norme
                    programs developed  revegetation methods that
                    did not require the use of overburden  nor
                    topsoil.  Seeding was done directly into
                    amended tailings  which has several
                    advantages.  There is a need for flexibility
                    in  establishing vegetation on tailings which
                    differ widely in  physical and chemical
                    properties.  A problem with the use of
                    neutralizing materials is the inability to
                    predict field  requirements by chemical
                    analysis.  Research was undertaken to

                    document dust control relations between
                    chemicals and mining  wastes in Canada.
KEYWORDS:           cat 08, 1983, canada, land reclamation,
                    vegetative  stabilization, iron ore mines
                    + mining, sulphur, tailings,  tailings ponds.

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          2,855 LINES,       130 DOCUMENTS          END OF PRINT REQUEST
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